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ORIGINAL PAPERS

SOME OBSERVATIONS IN THE CASTING OF HEAVY ELECTRICAL PORCELAINS[1]

By E. H. Fritz and A. L. Donnenwirth

ABSTRACT

A summary is given of experiences had in the manufacture of heavy and intricate electrical porcelains by the casting process. Some of the subjects discussed are selection and test of clays, mixing of casting slip and its control, and several details of the methods used in casting the ware. Special emphasis is placed on the limits established for viscosity and specific gravity of the casting slip and the general proposition that the slip must be within the limits set for viscosity regardless of specific gravity.

We have been casting heavy and intricate electrical porcelains for about two years. The process is undoubtedly more difficult to control and more sensitive to variations in clays than any other in the whiteware industry.

Variations in Casting Behavior of Clays

Successful casting depends primarily on the proper choice of clays. Most all clays will cast, but their manner of casting is radically different. We have fast casting clays and slow casting clays among both the china and ball clays. As a class the ball clays cast much slower than china clays.

Among the fast casting clays there are those which build up a firm solid wall from the mold to where the slip is casting and thus show a distinct change from slip to solid material. Others build up a firm cast adjacent to the mold but gradually the wall becomes flabby and soft as

[1] Presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Wares Division.)

the slip is approached. The wall appears to be well cast but when the supporting molds are removed, it often is so weak due to its semi-solid condition that it collapses. The former type of fast casting clays are the most desirable but the latter can also be used just as successfully where the sections to be cast are not very heavy. We have had very little experience with slow casting clays for with them we have been unable to cast heavy sections. Possibly they could be used for lighter pieces.

The classification of clays into these types can be easily made by the various methods which have been proposed, most of which employ a standard test piece to be cast and noting the casting behavior. To determine the cause of a clay's peculiar casting behavior is a more difficult matter. Grain size is a most important factor but it does not tell the whole story. We find that clays show considerable variation in casting behavior with no appreciable difference in grain size as indicated by settling. There are evidently other factors such as soluble salt content or a change in the nature of the colloidal material which affects this.

The Bingham Plastometer, like the settling test, will usually classify clays as to their casting value. We find that as a rule clays which show a low plasticity according to this test are the best casting clays. Plasticity tests do not, however, indicate the sometimes serious variations in a clay which alters its casting behavior.

We have read the suggestion of control of the hydrogen-ion concentration as a means of casting control. We have done some work on this test and are familiar with it. This test will undoubtedly give a measure of the amount of salts necessary for the slip, but we do not see how it can reveal a variation in the casting behavior of a clay which is not eliminated by a change in the amount of salts added. We will describe a variation of this kind in more detail, but it is well to emphasize at this time that this is the most difficult problem with which we have to contend in casting, and which so far has not been solved.

Relation of Design to Casting Rate

The designs which we are called upon to make limit us to clays which cast fast and solidly and which have low shrinkage in the mold. We have cast pieces where the wall varies from five inches to eight inches and in weight up to five hundred pounds, and we believe we can go further although it has not been necessary up to this time. For such work, the ball clay content must be kept as low as possible. We use no more than what is necessary to give the needed unfired strength so that the pieces can be handled without breaking. Eight to twelve per cent accomplishes this. As the ball clay is increased, the time of casting increases and the maximum thickness of section that can be cast is decreased. We have been able to finish the pouring of the largest pieces eight hours after it was started and the molds can

be removed twenty-four hours after the pouring was begun. Such a schedule indicates the importance to us of low shrinkage of the body while it is in the mold, and this is another factor which is considered in our choice of clays.

Preparation of Slip

In preparing the clay slip for casting, all the ball clay, china clay and scrap is placed in the mill, with sufficient water and sodium silicate for the entire charge, and ground for forty-five minutes. The amount of water and silicate is determined by the amount used in the previous charge, the water being measured by means of a meter and the silicate accurately weighed. To this is added the feldspar and flint and the entire charge is ground for thirty minutes more.

A check is made at this time, before the mill is emptied, on the viscosity and specific gravity and corrections are made, if necessary, to make the slip suitable for casting.

Testing of Slip

The viscosity is measured by the flow type viscosimeter and is expressed in the number of seconds required for 100 cc. to flow through an orifice $^{7}/_{32}''$ in diameter. We do not use a lid on this viscosimeter, which enables the test to be made more rapidly; but on the other hand a slight error is caused due to the difference in pressure, as the height of the slip decreases. By always filling the viscosimeter to the same point, however, the results are correct for comparative purposes.

For specific gravity determinations, we use a small necked bottle which is calibrated so as to express the weight in ounces per quart. This we find, to be much more accurate than a pint or quart measure.

The viscosity of the slip, before it is emptied into the cistern must be between 40 and 65 and the specific gravity must be 60.2 ounces per quart. These limits were established after some experimenting and also upon observations made in the casting shop, which will be described later.

The slip in the mill, after being checked, is passed through a thirty-mesh lawn into a storage cistern, where it is kept in motion continuously by an agitator.

Limits of Viscosity and Specific Gravity

Every morning the slip in the cistern is again checked before using. The viscosity must lie within the limits of thirty-five to fifty-five. It will be noticed that these limits are ten points lower than the limits set for the slip as it is checked in the mill, but we find that by agitating the slip over-night, the viscosity is lowered to this extent. This is due, probably to the fact that the grinding time being so short, the point of maximum deflocculation is not reached until the slip is further agitated. As an illustration of this, some time ago we made up a slip having a weight of fifty-nine ounces per quart and a viscosity

of forty. Blunging for eight hours additional reduced the viscosity to thirty-three, all other factors remaining the same. Continued blunging for sixteen hours reduced the viscosity to twenty-seven, but blunging for a longer time had no effect.

When we first started casting, a slip weight of 60.5 ounces per quart was maintained, and we were of the opinion that we could not change this weight, especially decrease it without encountering trouble such as excessive shrinkage. Everything went along fine for a time, until a change was noticed in that we could not maintain the proper viscosity, regardless of the amount of silicate used. The slip acquired a very sluggish appearance, the length of time required for casting increased and the slip would hang up in the mold, which prevented solid casting, causing what is termed "balling." In casting very thick and heavy pieces, we found on removing the side walls and core that the piece of ware would be so weak that it would sink down under its own weight indicating a soft flabby cast which, however, appeared solid.

We decided it was necessary to use a lower viscosity and there was only one way to accomplish this, and that was to lower the specific gravity. By reducing it to 60.2 ounces per quart, the viscosity dropped to within the limits and the trouble just described disappeared. The reduction in specific gravity was not sufficient to give any shrinkage trouble, and we have therefore used this weight since that time. This experience led us to believe that the viscosity is more important than the specific gravity and that the specific gravity should be reduced, if a satisfactory viscosity cannot otherwise be obtained. We are using this theory as a basis of our slip control and so far have had very satisfactory results. We believe that it is desirable to have a viscosity as low as possible at all times at a given specific gravity, but it is necessary that we set a lower limit because of settling. A viscosity below thirty-five will cause the heavier particles to settle more or less. In other words, we seem to encounter this before maximum deflocculation is reached.

It is, of course, understood that the specific gravity value should be set as high as possible, without exceeding the viscosity limits, on account of lower shrinkage and faster casting time. The important point, however, is that we reduce the specific gravity, if necessary to bring the viscosity to the proper value. When this is necessary a decrease of from .1 to .2 ounce per quart is usually sufficient to lower the viscosity from ten to twenty points.

Amount of Electrolyte Required

The amount of electrolyte required, often varies from day to day and over a period of six months fluctuated between 800 grams and 2200 grams. This is to be expected, however, and is probably due to a variation in the soluble salt content of the clays used.

Recently we received a car load of china clay which appeared to be no

different from any previous shipment, but on using it we encountered quite a bit of trouble. It was possible to bring the slip within the limits for viscosity and specific gravity, but the casting behavior was changed decidedly. It had a sluggish appearance, cast slower and hung up in the mold somewhat, making it difficult to obtain a solid cast in the heavier designs. It resembled the slip we were using when we were trying to maintain too high a specific gravity. This condition was improved slightly by maintaining a viscosity very close to the lower limits, but could not be entirely eliminated. Upon the arrival of another shipment of clay, the trouble disappeared.

There was evidently some difference between these two lots of clay, but up to the present time we have been unable to find a test which indicates it. A plastometer test or a settling test, as mentioned previously, showed a slight difference but not sufficient to segregate the clay which gave trouble from that which we know was satisfactory. It is a serious condition and we hope that a solution or helpful suggestions are offered by those who have had similar experiences.

Method of Casting Open top molds are used entirely. They are so superior to the funnel type that no other choice is possible. The slip is supplied by the continuous pump circulation method. This has been very satisfactory and seems to have no effect on viscosity. A ten-foot length of eight-inch pipe or a tank of some kind must be inserted in the line between pump and outlets to eliminate pulsation. The pipe lines are cleaned every evening with compressed air, to eliminate any chance of clogging.

Both core and drain casting are done, although the bulk of the work is by the former method. To facilitate release of the cores, an application of talc or compressed air is used. The former is more simple but not quite as effective and cannot be used when the cores are large and the taper not great.

For designs of variable thicknesses where wide sections occur in the lower part of the mold, it is necessary in pouring to fill the mold only in part, at first, thereby casting the wide section before any casting is done on the narrower sections above. Additional pours, must of course be made, before the top of the preceding pour has become too hard to unite.

We have tried to give a general idea of our casting methods, bringing out difficulties we have had and are still having, as well as those things we believe we have fairly well in hand. We have incorporated this information in a process specification which has been issued to the shop for their guidance and which cannot be changed without the ceramic engineer's approval, insuring definite control. We expect that it will have to be revised, perhaps frequently in the future, for casting is still new with us and we hope that as we progress, further improvements will be obtained.

THE WESTINGHOUSE HIGH VOLTAGE INSULATOR CO.,
LATROBE., PA.

Discussion

E. H. FRITZ: We have been unable to find any test that will indicate the variation which we sometimes (not very often) encounter in clays that we use.

W. L. SAMPLE: Do you take into account the difference in temperature of slip from time to time? That would give a different viscosity reading. In our plant we have quite a difference in temperature of the slip. On a cold day the slip will be quite cold and vice versa.

A. L. DONNENWIRTH: We do have variation in temperature. It varies from about 65° to probably 85°. This has a slight effect on the viscosity, but we take that into consideration.

W. L. SAMPLE: Do you have a graduated chart that shows that?

A. L. DONNENWIRTH: Yes.

CHAIRMAN MCAFEE: Speaking of differentiation in clays, do you make a viscosity test on clays or do you make viscosity tests on your slips? There might be some advantage to you in differentiating that.

E. H. FRITZ: The plastometer test referred to in the paper is something similar to that.

R. A. HORNING: That does not indicate this variation that you have. I thought a viscosity test was made on the clays before sodium carbonate was added.

R. W. HEMPHILL: We tried out the clays separately by casting them instead of this other test where they are put in a tub and are shaken up. Does that make any difference: to test out the china clay and see how long it takes, how much water, and if that varies any?

E. H. FRITZ: That might indicate the difference but what we are also after is why we have that difference. What is in the clay that causes that difference? If we know that we can test for it quantitatively and possibly be able to make adjustments for it.

C. W. PARMELEE: Perhaps Mr. Fritz has not taken into account the organic content of the product.

E. H. FRITZ: Probably not, but we have not had any trouble which we could trace to the ball clay. The china clay we use is English china clay and contains practically no organic material.

C. W. PARMELEE: What is the effect of time on that slip, a slip which is made today and not used for twenty-four hours or more? Have you noticed any material changes in the viscosity conditions or other conditions?

E. H. FRITZ: A minimum viscosity was reached after sixteen hours. But that would not necessarily be the same. You would reach maximum deflocculation sooner at one time than another.

A. S. WATTS: Were these results obtained from china clay which came uniformly from the same mine?

E. H. FRITZ: Yes.

A. S. WATTS: A short time ago the statement was made to me that some English clay miners at the present time are bleaching their china clay with a dilute solution of blue vitriol. I am wondering whether it could be possible that the presence of some bleaching agent would account for such a thing as this in regard to the behavior of the clay.

When I was in England I saw a lot of extremely blue water in the bottom of the clay mine, but I assumed that it was just the normal color of clear spring water intensified by a certain amount of clay in suspension, and I rather question whether there is anything of that sort used in the bleaching of English clay.

I do not pretend to know anything about the bleaching that is done in English china clays, but I raise the question in order to elicit information if there is anyone here who can tell us anything about it.

R. REIF: We had a carload of English china clay shipped to the plant. It was chalky and had a great tendency to crumble in my hand. We received another car some time later, same clay, same concern, but this clay was fatty and greasy. The chalky stuff would not work but the fatty stuff would. They had practically the same fineness. Can you explain it?

E. SCHRAMM: Did the clay have the same moisture content?

R. REIF: There was a difference of moisture content of one per cent.

E. SCHRAMM: Was there any chance of the one lot having been frozen?

R. REIF: Both came in about June or July.

H. GOODWIN: Do you use the china clay in the raw state or do they put it through a filter press?

A. L. DONNENWIRTH: We use the china clay in the raw state.

E. H. FRITZ: Would it be possible that contamination of the clay by ocean water on the way over might have something to do with that variation?

A. S. WATTS: There would not be very much opportunity for contamination unless the compartments become damp with sea-water.

E. H. FRITZ: We know of cases where there has been leakage in the boat.

A. S. WATTS: That may be possible. The sodium chloride would act very definitely, but I had never taken that into consideration because such an impurity would be abnormal.

A few years ago a large shipment of clay was put into the hold of a steel compartment vessel. The compartment had not been properly cleaned and a certain amount of iron rust was there which caused much argument.

CHAIRMAN MCAFEE: The point was brought out in the discussion on the English versus the American clays that at one time Mr. Brian found them slushing the ball clay down chutes into the boat, but he did not mention whether they used sea-water to slush it down or fresh water. However, I do not believe that is a common practice. It might possibly ex-

plain some variation in ball clay in case they use brackish water for that purpose.

E. H. FRITZ: For the casting process we have not been able to get an American china clay that will cast the very thick sections that we have to cast. It is possible to cast thinner sections with the American china clay but not sections over four inches. We have had no difficulty whatever with American ball clays. We use no English ball clay in our cast body.

A. S. WATTS: Some of the English china clay plants are filter pressing their clay and some of them are still putting it on top of the driers, a tile floor where the water is dried out. There would be a certain appreciable difference. If you were buying from a concern that was drying part of the clay by one process and part by another, that would undoubtedly introduce an error

H. GOODWIN: On the whole the English china clays are fairly moist when they leave the mines. Some of them are kiln dried and they are apt to get a little drier than those otherwise dried. However, I do not think that any absorption would take place which would affect the body.

There is no possibility, except in rare cases, of any salt water getting into the clay, because if there was leak in the boat of any amount the clay would be "soupy" when it was delivered and you would know there was something the matter. The boat people on the whole take very good care to keep the clay dry. They even go so far as to discontinue discharging when there is the slightest amount of rain at the docks.

SLIP MAKING AND CONTROL[1]

By Paul H. Sanborn

ABSTRACT

The properties of slip for casting solid pieces are discussed. Difficult control of slip and blistering are eliminated by use of an organic electrolyte. The effects of variations in specific gravity, viscosity and temperature are considered.

Introduction

The following discussion is based on observations made on slip for casting solid pieces used in the manufacture of electrical porcelain.

In a great many instances various troubles such as blistering of fired ware, difficult drying, and slow casting can be traced directly to the treatment of the slip. A few of the variables encountered in the preparation of slip and the effect of each will be discussed.

The Effect of Viscosity

It has been observed in practice that slips of high viscosity cast very rapidly, and that the time of casting increases as the viscosity decreases. When solid pieces are cast with slip of very high viscosity the portion of the slip in contact with the mold will cast very fast. This part will shrink away from the mold leaving an excess of water in the center. This results in a piece of varying density which will often crack in the drier due to the increased amount of water which must be removed.

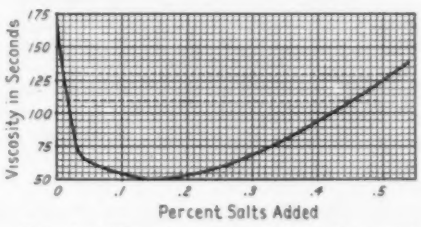

Fig. 1.—Viscosity curve 1:1 sodium silicate and sodium carbonate. J. D. I. Co. Sp. gr. 1.80.

The time of casting is considerably increased when slips of low viscosity are used. However, more uniform and dense ware is obtained. When the viscosity is very low the casting is much slower. There is also a tendency for the non-plastic materials to settle when large pieces are cast. Drying is more difficult when slip of this kind is used.

The Use of Electrolytes

The addition of electrolytes is one of the most important steps in the preparation of slip. (Fig. 1.) This curve shows the effect of an electrolyte which consists of a 1:1 mixture of sodium carbonate and sodium silicate. The first additions cause a very rapid drop in viscosity after which the effect becomes less. Further additions cause a more gradual rise.

The parallel lines represent the limits of viscosity which give the most

[1] Presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Wares Division.)

satisfactory results. It is possible to obtain the same viscosity at two points on the curve. However, the properties are quite different. The portion of the curve at the left is the one used in general practice.

Slow casting and drying are encountered when slip corresponding to the portion of the curve at the right is used. In drying, the water containing the salts in solution, moves to the outside of the ware, and is evaporated, thus leaving the salts concentrated at the surface. This is one of the most common causes of blisters. The quantity of salts is sufficient to cause a decided fluxing action on the body. The life of the molds is shortened by the action of the salts.

The desirable working part of the curve is very steep, consequently small change in concentration of the electrolyte will bring about a relatively large change in viscosity. Obviously it would be a difficult matter in practice to adjust the concentration of the electrolyte to bring about the desired condition. This is accomplished by the use of a Missouri clay of unusual characteristics. This clay contains a natural electrolyte of an organic nature, the effect of which is extended over a period of time. In the particular process used, the slip when made has a viscosity of about 180. It is then aged for a period of four days. During this time the viscosity will drop to about 125, at which point it is ready for use. This change is brought about without the addition of any deflocculating agents. If the viscosity drops below the lower limit, it is only necessary to add a very small amount of a flocculating agent.

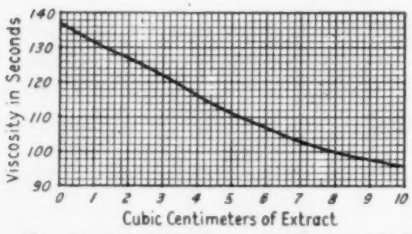

FIG. 2.—Viscosity curve. Missouri ball clay extract slip—600 cc. 1.80 sp. gr. Extract—5 grams lignite boiled 5 minutes in 200 cc. distilled water.

The Missouri clay contains a large amount of lignite. This lignite seems to contain most of the electrolyte in the adsorbed state. When five grams of the lignite was boiled in 200 cc. of water for five minutes, the extract was found to have a pH value of 8.0 (Fig. 2). This curve represents the change in viscosity with the addition of the extract, showing the deflocculating properties which the clay has. The effect of this electrolyte can be adjusted to meet different conditions by varying the amount of the clay. This clay can be substituted for china clay. An electrolyte of this type is very desirable. It is readily oxidized in firing and leaves nothing to exert a fluxing action or to cause blisters. The effect on the molds is very slight.

The Effect of Weight

If the specific gravity of a slip is high an excessive amount of electrolyte is required to bring it to the proper working condition. The action toward

electrolytes is often very erratic. Slip which is too light will delay the time of casting and will be difficult to keep in suspension. The proper weight of slip can only be determined by experiment.

The Effect of Temperature

Viscosity is greatly affected by temperature changes (Fig. 3). The speed of flow of the water through the body is a function of the temperature. The proper temperature of slip for casting can be determined by experiment.

In attempting to control slip it is necessary to take into consideration all the factors which enter into the preparation. A variation in one will cause variations in the others. The best method seems to be that of holding as many as possible at a constant value. If the weight and temperature can be held constant the viscosity can be adjusted with some degree of certainty by means of electrolytes.

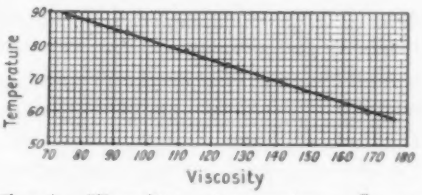

FIG. 3.—Viscosity *vs.* temperature. Sp. gr. 1.80.

The weight of the slip is taken by means of a 500-cc. volumetric flask, which has the neck removed at the graduation line. The flask and the slip are weighed in grams and a table consulted, giving the weight in ounces per pint. The specific gravity is easily obtained from the same figure. This method gives good results in the hands of the workmen as the chance for error is small. The viscosity is taken by means of a viscosimeter which has an arbitrary scale. A viscosity of 100 seconds represents the danger line and requires immediate correction. By having this standard to work from, the men are able to appreciate the effect which the viscosity has.

THE JEFFERY-DEWITT INSULATOR CO.,
KENOVA, W. VA.

Discussion

C. C. TREISCHEL: The question of control of the casting slip is no doubt one of the most important questions in the proposition of casting.

K. M. SMITH: What is the meaning of the term that pH is equal to 8?

P. H. SANBORN: The pH value represents the concentration of the hydrogen ion, or in this case, the hydroxyl ion. It is obtained by two methods. One requires quite an elaborate array of apparatus, the electrometric process; and another is by means of the colorimetric process, which has the disadvantage of requiring a very clear solution in order to observe the colors.

The electrometric process or method is very much more accurate be-

cause turbid solutions can be used. However, the apparatus is very expensive, and you want to be sure that you have a need for it before you get it. That measurement was made in order to determine the character of the extract of this ball clay. The other ball clays which we use show a slight acid reaction. Hydrogen-ion concentration of seven is the neutral point. A concentration of pH value of 8 represents slight alkalinity. It is a very accurate means of determining the slight alkalinity or acidity of any solution.

E. H. FRITZ: Would the hydrogen-ion concentration determination indicate the variation in the clay which we spoke of in our paper? We stated that we did not seem to be able to take care of it by trying different amounts of electrolyte. That was a "cut and dried" method, however We tried various amounts of electrolyte. We were able to lower viscosity with increased electrolyte, but this did not eliminate the trouble. Higher viscosity did not correct the condition either.

L. NAVIAS: $H_2O = H^+ + OH^-$. The water dissociates into hydrogen and hydroxyl ions. In other words, water contains these two ions and the Law of Mass Action states that the hydrogen ion and the hydroxyl ion are contained in equivalent amounts at equilibrium. It is a fact that at room temperature of roughly 22°C the concentration of the hydrogen ion and the hydroxyl ion in the water has the value of 10^{-14}, and therefore each of the concentrations, that is, of the hydrogen ion and of the hydroxyl ion, will be 10^{-7}, as the water breaks up into hydrogen and hydroxyl ions of equivalent amounts, and this (10^{-14}) expresses the total value of the dissociated water present. So that the neutral point in this equilibrium really means that there are as many hydrogen ions as there are hydroxyl ions and under those conditions the neutral point will have the value of 10^{-7}.

If we add an acid to the water solution, as HCl which dissociates into hydrogen ion and chlorine ion we will be increasing the concentration of the hydrogen ion and decreasing the concentration of the hydroxyl ion, but the equilibrium constant will always remain the same. In this manner we can increase or decrease the hydrogen ion to any value at will. 10^{-7} is the hydrogen-ion concentration. The pH value is merely another way of expressing it, namely, as the logarithm of the reciprocal of the hydrogen-ion concentration, $\log \frac{1}{157}$. The pH value in this case would be 7, and the increase in this value, say, to 8 would actually mean a decrease in the hydrogen-ion concentration.

P. H. SANBORN: Mr. Fritz asked a question about our application of this method of measurement. I will have to say that it does not tell the whole story. There are a number of other factors that must be taken into consideration. However, if used in connection with viscosity you can

pretty well tell what to expect the viscosity to be by the treatment with certain electrolytes.

H. GOODWIN: What percentage of this was ball clay?

P. H. SANBORN: We use a mixture of two ball clays. We vary it according to temperature conditions. In the summer time we cut down on it a little bit and in the winter time we can increase the amount. We can get where we want to on the viscosity by the proper judgment of this clay since it carries its electrolyte with it.

C. C. TREISCHEL: Would a body of the particular type which Fig. 1 represents, if deflocculated with an inorganic deflocculating material cast better in this range here between the parallel lines?

P. H. SANBORN: Yes, regardless of whether it is organic or inorganic. That seemed to be the best range, the one within the parallel lines.

C. C. TREISCHEL: As a slip is deflocculated within this range (25 or 30) ages, will it tend to get thicker?

P. H. SANBORN: No, the slip will get thinner, the viscosity will become lower as it ages.

C. C. TREISCHEL: If deflocculated with inorganic material?

P. H. SANBORN: If inorganic material is used it will drop in viscosity for a certain period of time, after which it becomes set or begins to thicken. The viscosity becomes higher.

C. C. TREISCHEL: Is the reason for the dropping a matter of not mixing it long enough in the blunger before it goes into the agitators?

P. H. SANBORN: Yes, that is probably the reason.

C. C. TREISCHEL: Then am I right in assuming that with your method of deflocculating with the organic material, you deflocculate over on this side of the curve? (Right side.)

P. H. SANBORN: We try to keep away from that part of the curve. If during our process of aging the viscosity drops below the lower limit there, or the lower parallel line, we will add acetic acid or some similar flocculating agent to bring it within the bounds.

C. C. TREISCHEL: If you get down below this point and add acetic acid, then am I not right in assuming that you thoroughly deflocculate your clay in the preliminary mixing.

P. H. SANBORN: We add no sodium carbonate or silicate or any other deflocculating agent to the slip at any stage, so at the time it is made it will have a viscosity of about 180, and during the period of the four days aging the viscosity will drop close to the range between parallel lines.

C. C. TREISCHEL: I cannot get your point of view. It may be because it seems to me that with what you do and with the answers which you have given to my questions you must be over in this range in deflocculation rather than in here with your organic materials. And as it ages it gets thinner by coming down this curve here, so that if you come below this

point and a flocculating material is added, such as acetic acid, you would throw yourself over on this side of the curve.

P. H. SANBORN: If you had the slip at the end of the four-day period and the viscosity went down, you could be pretty sure you were on the left hand side of the curve, could you not?

C. C. TREISCHEL: Yes.

P. H. SANBORN: Well, that is what happens.

C. C. TREISCHEL: You are here (left side) then. I was wondering whether you were over here on the right side, and if you were, whether there was any difference between the casting action on the left side and the right side.

P. H. SANBORN: We have used slip on both sides. In order to tell which side of the curve we are on we take the slip and add sodium carbonate, and if the viscosity goes down, we know we are on the left hand side, and if it goes up we know we are on the right hand side.

C. C. TREISCHEL: Are the results the same?

P. H. SANBORN: No, the results are quite different.

A MEMBER: May we ask what sort of ware you cast, please?

P. H. SANBORN: We are casting high tension insulators in open top molds. They weigh about 33 pounds apiece. We make three pourings per insulator. It is very necessary that we get the proper bond between different pourings. While we were operating on the right side of the curve we found that a decided scum showed up which interfered with the bond. That was due to the increased amount of salts which were concentrated there on the top due to the evaporation of the water which prevented the best bond between the different pourings. However, on the left side of the curve, we are entirely free from that scum and the different pourings are bonded properly.

C. C. TREISCHEL: It is quite evident then that the deflocculating action of the organic material is much slower than that of an inorganic material.

P. H. SANBORN: Yes, it is not very rapid. It stands over a period of over four days. It takes a four-day period to get the viscosity which we desire.

E. H. FRITZ: Why is the lower limit set so far above the point of maximum flocculation? Would it be desirable to go down as far as 75? You would still be on the left hand side of the curve. What trouble is encountered in doing that?

P. H. SANBORN: We allow ourselves a good margin above the settling point. The slip will settle in the neighborhood of 80 viscosity.

E. H. FRITZ: Do you encounter settling before maximum flocculation is reached?

P. H. SANBORN: Yes.

F. S. HUNT: Casting is not one of our problems, but in working with

sodium carbonate and silicate in factory conditions it is almost next to impossible to work with a slip that high up on that curve. Most people are working, I believe, down at that 75 point and have a chance to keep it somewhere uniform. A slip up on that part of the curve is very much more subject to variation than one down further on the curve, unless this ball clay acts differently than sodium carbonate and sodium silicate.

C. C. TREISCHEL: I think there is one thing Mr. Sanborn has brought out with respect to that, and that is that it is much less active. The action is much slower and extends over a period of days while the inorganic deflocculating material takes effect in a matter of a few hours. There is a difference there.

E. H. FRITZ: That is an individual condition depending on what is being cast and how the viscosity is determined. Our viscosity limits are very low numerically. Very likely our viscosity is not any different from Mr. Sanborn's; it depends upon what kind of ware is being cast.

F. S. HUNT: I was bringing out the point that you are trying to work that on that curve of viscosities.

E. H. FRITZ: I meant that, too.

W. K. MCAFEE: I would like to hear this discussed from another view than that of electrical porcelain. Our own experience in casting control is that the viscosity readings are not reliable so far as we are concerned. We work specific gravity the same and test the action of the slip in actual test cast. Our viscosity varies greatly, and does not seem to prove anything so far as our own particular process in casting sanitary ware is concerned. We do not pay any attention to viscosity.

P. H. SANBORN: With this particular body used here, which has a ball clay content of 6%, and since the settling point occurs as a viscosity much above the point of maximum deflocculation, it is necessary to pay very close attention to the viscosity.

C. C. TREISCHEL: With a low ball clay content it is much more likely to settle than one having 15% or 20% ball clay.

W. K. MCAFEE: I would like to have that side of the argument brought out by some discussion.

C. B. YOUMANS: We are casting sanitary ware and about three or four months ago we tested for specific gravity and held to that, but then we thought we would try something else along with specific gravity and we tried this viscosity, and we found that had a great deal more to do with the casting than specific gravity. We can vary specific gravity possibly one or two grams but if we vary in viscosity as much as two or three minutes it will throw us way out. Since then we have been trying to hold to a viscosity instead of a specific gravity.

W. K. MCAFEE: I did not mean to convey the impression that our viscosity varied quite that much.

C. B. YOUMANS: We have ours vary as much as two or three minutes and when we do we are in a lot of trouble, but we can cast within a minute's variation and have no trouble at all.

W. K. MCAFEE: That is the same point I wanted to bring out, that it could vary over a considerable range. We have found that specific gravity needs to be kept fairly uniform for our particular method.

E. SCHRAMM: What is the percentage of change represented by two or three minutes?

C. B. YOUMANS: If we come down to two minutes for 200 cc. we can still cast with three minutes for 200 cc.

K. M. SMITH: Do you find that the man making the slip can determine the viscosity a great deal by pouring the slip, or by feeling of it with his fingers?

C. B. YOUMANS: We are working on such a heavy schedule, we do not have time to try all of these little individual tests. We are making about 40 to 50 tons of slip a day, and we are working on such a fast schedule that we do not test every batch. We only test in the agitator once a day, usually in the morning before we start.

K. M. SMITH: We have an Italian making the slip up at the other plant and he can judge the viscosity very nicely by blowing on the slip. He makes very good slip.

E. SCHRAMM: In a great many potteries that manufacture whiteware it is left to the workmen to a certain extent because the slip is not delivered and controlled. It is delivered in tubs, some is used and then it stands around until more is put in it. No one has ever devised a way of avoiding that situation. We control our casting slip as we make it, but beyond that it is out of our hands. We have never felt at liberty to forbid the men making adjustments, especially on the specific gravity of the slip. We feel that we have to rely on their personal skill in the last analysis.

E. H. FRITZ: Was any difference ever noticed in casting the slip which had a viscosity which was high where the specific gravity was all right?

W. K. MCAFEE: If the viscosity gets too high, that is, beyond the limits suggested by Mr. Youmans, of course, it does not drain right in hollow casting or over-casting, but up to that point where it does not actually drain right in the mold, it does not make a great deal of difference. It will have some effect on drying and setting up, but the temperature and mold variations seem to make more difference than that. As compared with the other variations that enter into casting, viscosity does not seem to be so important.

E. H. FRITZ: What would you do if the specific gravity was satisfactory but the viscosity was not?

W. K. MCAFEE: We would probably add more salts to bring it down because we seem to be high enough up the left hand side of the curve to

make that correction. We are frank to say we do not know very much about making slips so far as technical control is concerned.

E. T. MONTGOMERY: I would like to ask Mr. Fritz if he uses gravity or forces the slip out by air pressure.

E. H. FRITZ: By gravity.

E. T. MONTGOMERY: Do you empty through a pipe line or valve?

A. L. DONNENWIRTH: We empty the mill through a valve by gravity. Air pressure is used in addition to merely speed up the operation.

E. T. MONTGOMERY: If air is used it brings in another factor which would affect the use of the ball mill as a viscosimeter. That is the reason I asked the question. When emptied by gravity and through a valve I was wondering if you found the ball mill to be rather an accurate viscosimeter itself. If your mill will empty properly have you still the possibility of too great a variation in the viscosity?

A. L. DONNENWIRTH: You can notice a difference in the viscosity. If it is too high it takes a much longer time to empty the mill.

E. T. MONTGOMERY: Is the ball mill a sufficient guide, or must you make a test with a viscosimeter?

A. L. DONNENWIRTH: We have never used it as a guide. We always make a test with a viscosimeter.

E. T. MONTGOMERY: I have found in my practice in making very small quantities of slip that the rate of flow from my ball mill is a sufficient test for me.

A. L. DONNENWIRTH: When the mill is finished we take a small sample. It only requires about two minutes at the most to make that test, so you see we do not waste much time and it is much more accurate.

E. T. MONTGOMERY: Except that you are dealing with a small quantity and perhaps the test on the larger quantity might be even more practical than that and of equal value. That is the point I had in mind.

E. H. FRITZ: I do not believe it would be close enough.

K. M. SMITH: I would like to ask Dr. Navias if it would be possible to dilute a slip down with distilled water and then add a color such as methyl orange and titrate with a known solution. What kind of a factor would you use to convert it over into a hydrogen-ion concentration?

L. NAVIAS: The soil chemists have done a great deal of work along these lines using the colorimetric method for their pH concentrations.

K. M. SMITH: What color do they use?

L. NAVIAS: They have a series of indicators. There are quite a number of organic acids or bases which exist in tautomeric forms in equilibrium with each other in solution. They also have the property of changing their color at the transformation corresponding to a definite hydrogen-ion concentration. That is what is used in the colorimetric method.

For instance, phenolphthalein is a good example. At a definite pH

value, that is, at a definite hydrogen-ion concentration it changes from colorless to red. This is purely a comparison method standardized by the electrometric method. The pH value for the change in color is determined once for all, and so it is just a matter of finding a number of organic compounds of this type with values which are spread over the field.

Washburn has taken a number of salts of organic compounds and plotted them in a curve of this type in which he gives the name of the salt, and also the pH value at which it will change from one color to another, and you can find that published in quite a number of hand books.

The soil chemists, of course, have made a big study of the indicators. Dr. Clark of Washington has done a great deal of work along these lines. It is just a matter of getting together a number of suitable organic compounds that will be converted, one at a pH value of 7, another at 8 and another at 9, or intermediate values, and using the series for the determination. In the actual determination it is just a matter of taking the water solution of whatever material you are dealing with and adding known concentrations of your indicators to it under control conditions and noting where the change takes place.

There is a very fine method discussed in the literature[1] whereby one can determine the intermediate values between the color changes by a comparison method. One set of test tubes containing different quantities of indicator is made alkaline, while another set is made acid. The color of the indicator in the unknown solution is then compared with the intermediate colors obtained by coupling the "acid" and "alkaline" standard indicator solutions.

K. M. SMITH: May I ask where and to whom to write to get this information and if this series is set up in shapes so that a person can buy standard solutions?

L. NAVIAS: Yes, you can. I am not advertizing anything but I might mention off hand a company, I think it is the La Motte Company, which produces a series of indicators ready for use.

[1] "Colorimetric Determination of H-Ion Concentration without Buffer Mixtures, with Especial Reference to Soils," Louis J. Gillespie, *Soil Science*, 9, 115–36 (1920).

SYMPOSIUM ON CASTING PROBLEMS[1]

Question 1 Is a higher firing temperature or a longer soaking period required to accomplish complete vitrification of a cast body, compared with the same body used in plastic form? (By G. W. Lapp.)

C. C. TREISCHEL: I know of some who have used the same body exactly for casting that they do for wet process.

C. S. MADDOCK, JR.: We use the same body for casting that we do for pressing. We have made no change in our firing conditions because we see no difference in the firing of the cast or the pressed ware.

F. H. RHEAD: The type of ware and clays used should be considered in answering this question. Why not cast and press a similar shape with the same body, firing these in the same sagger at a temperature approximating vitrefaction?

Absorption tests could be made, and if the cast piece proved to have higher absorption than the pressed piece, it is reasonable to assume that a slightly higher firing temperature or longer soaking period might be necessary to accomplish the complete vitrification of a cast body compared with the same body in plastic form. It should be obvious that different mechanical treatments in connection with clayworking processes would more or less result in physical differences in the bodies when subjected to the same firing conditions.

Assume that a typical earthenware or sanitary ware body was used in making a round disk exactly eight inches in diameter and $^1/_4$-inch thick (mold size) by the following processes:

A. Dust pressed. Moisture content 10%. Pressure 500 lbs.
B. Dust pressed. Moisture content 15%. Pressure 3000 lbs.
C. Cast, without salts, 24 ozs. to the pint.
D. Cast, deflocculated slip, 32 ozs. to the pint.
E. Pressed, moisture content, about 25%.
F. Jiggered, moisture content, about 30%. Ordinary knife edge jigger tool.
G. Jiggered, moisture content, about 30%. Flat heel wooden jigger tool.

and that these slabs were all fired in the same sagger until the average absorption would be about 3%. When the slabs came from the kiln and were measured it would be found that there would be a variation of from $^1/_{16}$ inch to at least $^3/_{16}$ inch in diameter, and that the absorption would vary at least 1%.

In casting heavy clay products there is sometimes enough weight and pressure combined to offset any marked physical differences between cast and plastic processes as far as contraction and absorption are concerned. But this again depends on the particular treatment and composition of body.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Columbus, Ohio, Feb., 1925.

H. GOODWIN: Due to our disastrous fire and complete destruction of scales, I cannot arrive at any definite conclusion. However, you can assist to some extent, so I am sending you by Parcel Post two pieces marked "C" and two marked "P" at the time they were made and dried. The pressed pieces were as I recall somewhere about one ounce heavier (avoirdupois).

I would suggest that you weigh these four pieces, then determine the absorption. This will show the relative density difference between a cast or a pressed piece. Orton cones 6, 7 or 8 were fired with these pieces, and Veritas disks, and although one piece marked "C" and one "P" were fired in the same sagger there is no difference in points registered by the disks. Sometime later it may be possible to pursue this study further.

REPORT BY A. E. MACGEE:[1] The dry weight of the two cast bowls is 504.3 and 489.5 grams respectively. The dry weight of the two jiggered bowls is 515.0 and 547.5 grams respectively.

The porosity of the two cast bowls is 22.67% and 20.86% respectively. The porosity of the two jiggered bowls is 20.08% and 19.75% respectively. The porosities were determined after soaking in distilled water for $1\frac{1}{2}$ hours, boiling 1 hour and standing 17 hours. The dry weight, saturated weight and suspended weight were taken.

C. C. TREISCHEL: It would seem then that the amount of alkali that is used for deflocculation has no effect whatever upon the maturing temperature of a body.

R. W. HEMPHILL: We make cast ware out of the same body as is used in pressed ware, firing the cast in the bottom part of the kiln. The dry press has to be placed higher. The cast ware will vitrify in the bottom of the kiln. The same body by wet process has to be fired harder.

C. C. TREISCHEL: Have you any idea in percentage how much alkali the body uses?

R. W. HEMPHILL: No.

C. C. TREISCHEL: Ordinarily on the basis of half soda ash and half water glass about 0.4% is what is used. If you are going higher than that the concentration of alkali might play some part.

R. W. HEMPHILL: About 100 ounces of alkali to 1600 pounds of clay, I believe.

C. C. TREISCHEL: The alkali percentage then is about 0.4%.

W. K. MCAFEE: I have had no personal experience, but a plant that we took over was formerly using the same body for casting and pressing sanitary ware. They reported that the cast ware was fired harder through the same firing conditions in a tunnel kiln than the pressed ware. It was apparently vitrified a little bit more. You could tell the difference in the color and in the ring of it.

[1] July 14, 1925.

T. W. BLACK: I have found where I have used colored slips on cast ware that the colored slips vitrified quicker than they did on pressed or other ware. I do not know whether the electrolytes in the cast ware have any effect or not, but it appears that they have.

Question 2 To what extent do electrolytes used in preparing casting slips replace feldspar and other fluxes in completely vitrified bodies?

C. C. TREISCHEL: This was discussed in the first question.

Question 3 How do the drying shrinkage, firing shrinkage and maximum density of a cast body compare with these properties in a similar body made up in plastic form?

C. S. MADDOCK, JR.: We do not notice anything in the body. We use a slip of 32 ounces to the pint and can find no appreciable difference between the cast and the pressed ware. The cast body will be a little bigger.

M. R. HORNUNG: We do not differentiate between the drying and firing shrinkage, but their total will be smaller with the cast piece than with the pressed piece.

C. C. TREISCHEL: That is with a slip of what weight?

M. R. HORNUNG: The slip is about 30 ounces or perhaps 29. That is for china.

Question 4 What measures should be taken for correcting a slip that requires excessive electrolyte?

C. C. TREISCHEL: If we should consider that a slip for casting would normally contain about 0.4% alkali, based on materials used, how could we correct a body which requires 0.6% for deflocculation; what changes could we make in that body to get it down to 4%?

A. FOLTZ: Some of us have never had any experience with a body that required that.

C. C. TREISCHEL: Suppose you are using 0.35% of alkali and you want to get a body which will use 0.25%, how would you go about working out such a body?

T. A. SHEGOG: We would lower the ball clay content to the amount of electrolyte required, because it is on the plastic material of the clay that the electrolyte acts. We would reduce the ball clay.

C. C. TREISCHEL: Has any one found soda blisters in a cast like this and overcome them by a body change?

F. H. RIDDLE: Suppose we did not know anything about casting at all, like a man out of school who wanted to get a casting slip. If he did as he had been taught, he would probably get all of the clays that he knew of or could find out about which were clays that had been used successfully. He would try out each of those clays individually to see how they behaved

with electrolytes. Then he would pick those clays which seemed to have the widest range where the effect of the electrolyte was as uniform as it could be; also, those clays which required the least amount of electrolyte to give the best results and work on those as a starter for his body.

Another thing he might also do is to study the literature and instead of doing the work himself find out what others have done.

E. SCHRAMM: I should like to say that Mr. Shegog's statement about the action of the electrolyte on the ball clays is not consistent with the work which we have done in the deflocculation and sedimentation of clays. The ball clays are characteristically dispersed as we get them whereas the English china clays are usually highly flocculated. It would be my belief that the action of the electrolyte to deflocculate the clay would be on the china clays rather than on the ball clays. I have had no direct practical experience with changing the ball clay content of casting slips. This is simply an opinion based on my understanding of the properties of the different clays.

K. M. SMITH: I think that can be easily shown. If you take plastic clay and dope it up it will usually get thicker. That goes to show that the ball clays and plastic clays are natural deflocculating agents. The higher you get a ball clay the less dope you need. It seems to me that the deflocculating reagent acts on the china clays and not so much on the ball clays.

T. A. SHEGOG: The question has been raised on what portion of the clay does the agent act. If we accept the colloidal theory that the electrolytes can act only on the colloidal matter in the clay, we must remember that china clays are very low in colloidal material. I have found figures like $^1/_2$ of 1% colloidal matter in English china clay and up to 5% in English ball clay.

It would naturally take more electrolyte to act on 5% of colloidal matter in English ball clay than it would on $^1/_2$ of 1% in the china clay.

W. K. MCAFEE: One of the ceramic engineers of a Trenton sanitary pottery has succeeded in reducing his electrolyte in a laboratory experiment to almost unheard-of limits by increasing the ball clay content in the body. That would seem to confirm Dr. Schramm's statement. I believe the solution would be to increase the ball clay rather than to decrease it.

R. W. HEMPHILL: We have two casting bodies. One is about 23% ball clay and takes 0.4 of 1%. We have another one with 16% or 18% of ball clay and that takes about four-fifths as much electrolyte which is just the opposite.

I. E. SPROAT: This difference of opinion seems to be due largely to the type of ball clay that they are using. A lot of our ball clays contain organic electrolytes. If we use a light colored ball clay with a small amount of organic material, ten chances to one it will take more electrolyte. On

the other hand, if we use one containing a large percentage of these organic electrolytes it will take less.

C. C. TREISCHEL: A little experience I have had along these lines seems to indicate that an increase in the ball clay, particularly of the types that we were using, for casting electrical insulators, reduced materially the amount of alkali necessary for deflocculating that particular slip.

We started out using about 12% ball clay, and with the same ball clays increasing to about 22% decreased the amount of alkali by about one-third. Then we changed the ball clays, and finally with the same 22% of ball clay content reduced the alkali to slightly less than one-half of what it was originally. It was slightly less than one-half, because originally we were using soda ash and sodium silicate on a half and half basis, and we used in the last body the same amount of soda as we used at the start and eliminated entirely the sodium silicate. Sodium silicate is regarded as a more active deflocculator than the sodium carbonate. That was with Tennessee and English ball clay. There was a change in the ball clay type used, showing that no doubt the organic salts carried by the clays played an important part.

T. A. SHEGOG: Do you not think in this discussion that we should confine ourselves to the same ball clay? If an increase in ball clay reduced the electrolyte required, would it not be logical to suppose that the time would come when we would either use no electrolyte at all or actually have to add a deflocculating agent, acetic acid or something else? I mean to say if the actions are inverse, would not the time come when by sufficiently increasing the ball clay we would not need an electrolyte at all?

D. W. ROSS: Mr. Sproat, will you enlarge upon this idea of organic salts, what some one or more of them are; what their general nature is?

I. E. SPROAT: If you can get an organic chemist to make an analysis of these clays and tell us what they contain, I would be satisfied. It is a difficult thing to say just what they contain.

F. H. RIDDLE: If you have a clay that acts as a deflocculating agent or saves us from using silicate of soda and sodium carbonate, in the end, are we any better off? Do these salts, which occur naturally, do less harm in a body than those which are added; in other words, is it an advantage to cut down on the additions of electrolyte?

R. E. REIF: We were bothered with soda blisters, but we are now making a slip without any soda at all, just with straight silicate, and have eliminated soda blisters altogether. We made this adjustment with our darker ball clays.

H. GOODWIN: Are soda blisters due entirely to the action of the soda? I think we shall find it true that when the deflocculent becomes part of the body it will have some effect upon the question.

I. E. SPROAT: The soda salts come to the surface and blister.

F. H. RIDDLE: Is there anything else that comes to the surface outside of these highly organic ball clays, if there is no soda that is not put in?

I. E. SPROAT: Organic acid very seldom comes to the surface. To a certain extent then it is an advantage not to have to use the salts.

C. C. TREISCHEL: That point was brought out by Mr. Sanborn somewhat in his paper, in which he told about the blistering trouble being eliminated by reduction in the use of alkali.[1]

Question 5 What troubles would one expect with an excessive amount of electrolyte in drain and in solid casting?

If we had a body that normally required 0.35% alkali, and through some change in the clays with which we were not familiar, we found that we had to increase the alkali content up to 5% in order to get the same results with regard to specific gravity and viscosity, what trouble would that cause in drain casting? Would it tend to hang, or not drain clean?

M. R. HORNUNG: That does not have so much to do with the amount of electrolyte as with the thickness of the slip. If the slip is thin enough it will drain pretty well regardless of the amount of electrolyte in it.

PAUL TEETOR: Slip requiring an excessive amount of electrolyte usually works satisfactorily if it is not too thick. Balling, however, may take place; that is, there seems to be a tendency for the slip to congeal after it has been poured into the mold. There will be little trouble with a piece which casts quickly, but with a piece requiring one and three-quarters to three hours to cast, the slip may sometimes thicken enough so that the slip becomes so viscous that the pressure can not force the slip into the more remote portions of the mold. This results in a tendency toward hollow casting, or in balling. Especially is this true if it occurs where a web branches off from a side wall. If it is completely deflocculated it drains very nicely. If it is not, there is some tendency to hang and not drain clean.

C. S. MADDOCK, JR.: When we first went into casting we used a solid cast of about $^5/_8$ to $^3/_4$ inch. When the men complained of the slip not working right, one of our foremen promiscuously added salts to suit himself, and to satisfy the workmen. When that ware came from the kiln, we found excessive blisters, or, after a period of 24 or 48 hours some of the ware would dunt. In one case they went up to 50% of dunted ware out of a kiln.

At this time we were experimenting with one-fire ware. We discovered that in the one-fire ware, where the glaze was put on the clay, that all the pieces made with clay having excess salt came out good. We put all the ware of the clay having excess salt through one fire without losing any of it.

F. H. RHEAD: The condition experienced by us in connection with an

[1] See pp. 555–64, *This Journal*.

excessive salt content has been that we always had a deposit on the ware when it came from the bisque kiln. In addition to this, the molds developed a heavy film or crust, and for a period we had to scrub the molds after each casting. When we cut down the salt content, the deposit on the bisque ware and the film on the molds did not occur.

C. C. TREISCHEL: In other words, you had more attack on the mold from an excessive amount of electrolyte and also on the ware itself. What was that coat on the ware? If you had broken the ware could you distinguish a difference in texture at the surface and in, we will say, up to $^{5}/_{1000}$ to $^{10}/_{1000}$? Was the texture the same?

F. H. RHEAD: The coat or film generally appeared on the upper surfaces that were exposed, both during the drying and firing periods. In the case of vases, the coat would be around the edge and on the top of the handles. If the vases were dried and fired up-side down, the coat would occur at the base, or in other words, at those surfaces that would dry first.

C. C. TREISCHEL: Could it be removed readily by sponging or scraping?

F. H. RHEAD: No. In most cases, the coat was not in evidence until after the bisque fire. The coat had a glossy blistered surface and was sometimes quite red in color.

C. C. TREISCHEL: Could you notice it in the green ware?

F. H. RHEAD: No.

T. A. SHEGOG: I had a case some time ago where cobalt sulphate was used for stain, and the accumulation of sulphate in the press water, which was used over and over again, became excessive. The foreman increased the amount of dope in his casting slip so as to decrease the viscosity. The slip was becoming thicker and thicker. We found that a state was reached when the surface of the ware, after the mold was drained, when exposed to the air actually dried faster than the surface in contact with the mold. When we used fresh water in our blungers the whole trouble disappeared. Whether this was due to an excessive amount or not, I am not prepared to say. I think likely it was.

D. W. ROSS: Part of a lot of ware affected similarly to that mentioned by Mr. Rhead, was fired with unsatisfactory results. By removing the surface coating with a soft dry brush the balance of the ware was reasonably satisfactory after firing.

C. C. TREISCHEL: You mean brushing it off from the green ware before firing?

D. W. ROSS: Yes.

A. S. WATTS: I saw a case similar to the one where they used the brush and they also sponged a lot of them. The sponge treatment did not seem to help at all; the salt worked into the surface on the dried ware. They did, however, correct the trouble by brushing.

H. GOODWIN: I had trouble of that sort. When biscuited the creams

and sugars apparently took the glaze all right, but from the glost kiln they had scarcely any glaze on the portions which had scummed.

Question 6 What causes "balling" and how may it be overcome?[1]

Question 7 What causes "pinholing" and how may it be overcome?[2]

Question 8 What mesh feldspar (and other non-plastics) gives best results in casting?

C. C. TREISCHEL: How about the fineness of your non-plastic material? What effect does that have on casting? Does it speed it up or slow it down? Does it have any effect on the amount of alkali necessary for deflocculation?

T. W. BLACK: There is no doubt but that the size of grain of the materials in a body are going to affect the casting but in what way I am not prepared to say. I believe it is very important. We have a very coarse flint (20% will not go through a 100-mesh screen) and I found that it cast as well as the finer flint, but that it was the cause of crazing. Dr. Mellor, who visited our plant, told me that coarse flint was one of the principal causes of crazing in the English potteries and that they now had eight men who did nothing but test the flint for the English potteries.

I decided that the more variegated the grains the better body I would cast, of course within certain limits, but that the coarse-grained flint would certainly cause crazing. It did not seem to diffuse through the body as it should. The grinding of the feldspar used in the body does not seem so important as the fine grinding of the flint.

F. H. RHEAD: I do not see that the size of grains makes any difference if the body is properly adjusted. We have casting bodies that are as fine as they can possibly be, and we have others using material varying from 8- to 20-mesh, and they all cast equally well.

T. W. BLACK: I did not mean that it cast better. We had no difficulties with the casting of coarser materials.

W. K. MCAFEE: I had a little experience with this flint question. We are informed by the people from whom we purchased our flint that we use a finer flint than most of the sanitary potteries. However, we sent a sample of our flint over to Dr. Bernard Moore in England and he told us that he had had no experience with any flint that coarse and could not advise us.

T. W. BLACK: Dr. Moore has a very simple elutriator for flint.

K. M. SMITH: It is not difficult to cast with various sized grains, but it is when the ware goes through the kilns that it gets the real test.

[1] W. K. McAfee, "Balling in Cast Ware," *Jour. Amer. Ceram. Soc.*, **8** [7], 430 (1925).

[2] R. W. Hemphill, "Observations on Pinholing in Cast Ware," *Jour. Amer. Ceram. Soc.*, **8** [3], 145–74 (1925).

C. C. TREISCHEL: What effect does the fineness of grain have on dunting? Will the fine grain flint give a cast body with a greater tendency toward dunting than the coarser grain flint, or vice versa?

F. H. RHEAD: I think this depends, first on the composition of the body and secondly, on the firing temperature. I recall an earthenware body biscuited at cone five that will dunt if 28% fine grain flint is used. But if the flint content is reduced about 5%, or the bisque temperature raised to cone 6, there will be no dunting.

I do not believe that the fineness of the grain alone, controls dunting or crazing. We make a variety of shapes and sizes with porcelain, stoneware, earthenware and terra cotta bodies. Certain porcelain slabs, approximately three feet long, twenty-two inches wide and a little more than one-fourth inch thick, are made with fine materials throughout. Such slabs will dunt if they are under-fired in the bisque and if allowed to cool too quickly.

C. C. TREISCHEL: Single fire or double?

F. H. RHEAD: Both.

F. H. RIDDLE: Were those vitreous, Mr. Rhead? Do you use setters for each as in terra cotta to fire them?

F. H. RHEAD: The slabs are quite vitreous. They are made in a two-part mold and are cast on edge. After the slab has been cast, we remove one side of the mold and replace this with a refractory slab which exactly fits the other half of the mold. The whole business is then turned over, the remaining half plaster mold raised, leaving the porcelain slab on the refractory slab. The porcelain slab is not moved from the refractory slab until it is fired.

F. H. RIDDLE: How is it placed in the kiln?

F. H. RHEAD: The refractory slab is placed flat on the top of the Harrop kiln. A handful of sand is poured on each corner of the porcelain slab.

Question 9 What are the possibilities of casting in rapidly revolving molds?

T. W. BLACK: My reason for asking that question was to find out if anything had been done. I understand that one pottery has been trying it out recently, casting plates and cups with handles on, but I also thought something might be suggested along the lines of drying molds by rapidly revolving them at a very high speed, about 1500 to 2500 revolutions a minute.

Some years ago in the Middle West a man was making cement vases and doing it by the dry process. They can be made very rapidly, but there is not a good crystallization of the cement. By using the wet process they have to stay a long while in the molds which necessitates a great many

molds. This man had the idea of revolving them at 2000 revolutions a minute. He was able to put the cement in quite wet, a little thicker than our slip, and get them out in two minutes.

Another instance was a lumber company in the southern part of America. I understand that lumber takes considerable drying before it can be turned on a lathe. It takes some months, I believe. This man took lengths of timber cut from the woods, revolved them on a table in somewhat similar fashion and was able within a half hour after cutting the lumber to turn it on the lathe.

If principles involved in these two very dissimilar cases are sound, they are applicable to any industry. Because a certain principle has not been used before is no reason why it should not be tried out, and if there is any method of drying molds by any system like that it would cut down the cost of molds quite considerably.

This system has been patented recently. They have a mold rapidly revolving on an inclined plane. The slip is poured into the mold and after revolving a few seconds the mold can be tilted and the excess slip throwing itself out into a receptacle. I do not know how far they have gone or how successful it has been, but the one point I had in mind was that while science has made great strides in chemistry of pottery very little has been accomplished on the engineering side of the question with the exception of kilns. In the formation and the general shop practice, the engineer has not been consulted.

An engineer could come into the business without any traditionary bias, and I believe we might get some remarkable results. For instance, one pottery I have heard of since I have been here, prepares the slip by passing it through a vacuum. They are also mixing their clays a little differently. They have a re-mix that comes from the pug mill. By eliminating the causes of unequal shrinkage of bodies during the drying and firing it would make the production of china ware or vitreous ware as simple as the making of semi-vitreous ware because it is the air in the body which causes deformation more than anything else. If the air voids in a body were eliminated or decreased or uniformly distributed through the mass, unequal shrinkage during the firing of the ware would be minimized, total vitrification would occur, quicker and more evenly. This seems to me a line of research for the engineer rather than the ceramist.

F. V. DRAKE: In answering part of the question of the previous speaker in reference to the engineering in potteries, it has been my experience that every time the engineer takes up a subject of that kind the potter refuses to coöperate. He wants the engineer to experiment until the thing is perfect, then possibly he will adopt it.

F. H. RHEAD: We worked out an experiment some time ago in regard to revolving molds. We were casting porcelain bowls, from sixteen to

eighteen inches in diameter, in the ordinary open molds. As we were having warping troubles, we put these molds in a jigger and sprayed the slip while the molds were revolving fairly rapidly. We made a number of pieces, none of which were over one sixteenth of an inch in thickness. There was practically no warping and the thickness was as uniform as a cast piece. As a sprayed surface sometimes develops a wooly texture, especially if the mold is too dry, we use a potter's rubber to finish the inside of the bowls.

E. SCHRAMM: Do I understand that you used no excess slip in that process but just sprayed in enough to make the form?

F. H. RHEAD: We sprayed in enough slip to build a coat of the required thickness.

E. SCHRAMM: Did you try drain-casting in connection with the revolving mold?

F. H. RHEAD: No.

R. W. HEMPHILL: I do not see why somebody does not get up a continuous filter press of some sort. Pump the liquid into the machine and have it come out in the shape of pugged clay. I think it could be worked out.

C. C. TREISCHEL: The man who is mining clay for use in the rubber mills described a process that might be applied here. (Spray drying as in the manufacture of powdered coffee.)

R. W. HEMPHILL: But that dried it too much.

Question 10 Can American ball clays and china clays be used in casting bodies?

T. A. SHEGOG: There is no doubt but that American ball clays and china clays can be used in casting bodies. We have been doing it for a couple of years.

C. C. TREISCHEL: This can be easily accomplished if necessary precautions are taken to accommodate the idiosyncrasies of the American clays as compared with the English clays.

If the whiteware industry in this country had been built up on the basis of American clays and we had tried to substitute English clays for them you would have had about the same problems as you sometimes have when you are doing the other thing.

T. A. SHEGOG: There would be exactly the same difficulties. We cannot transplant a process, but we can adapt it. There is not any great difficulty in that.

Question 11 What kinds of clays give the best results in casting bodies?

R. W. HEMPHILL: Do you consider talc clays in a thing like that?

C. C. TREISCHEL: Hardly.

R. W. HEMPHILL: Is cast talc body all right?

D. W. ROSS: Some years ago Mr. Cermak told me that the dark ball clays were the ones that would cast and dry most satisfactorily. On casting bodies containing the dark clays, a darker area is frequently found near the surface of the dried ware. It would seem from this that some of the organic materials, whatever they are, do actually travel to the surface and must be more or less soluble. What is the real opinion concerning the relative ease of casting dark and light clays?

R. E. REIF: Casting can be done as well with the light clay as with the dark, providing the alkali is adjusted. We have used practically altogether a white ball clay. If we use 1% silicate it casts just as well.

C. C. TREISCHEL: Is there anyone who has anything to say regarding the routine testing of clays for use in casting bodies? Are the clays which are used in the casting body tested in a different way than the same clays that are used in the plastic process, for instance? That question has been asked by Mr. McAfee. He is seeking information.

F. H. RIDDLE: If English china clays are used in the body and their behavior is tested with a definite amount of electrolyte, or if those clays are put into a slip with a definite amount of water so that the specific gravity is known, and then the electrolyte is varied and the viscosities are determined, the variation in one car from another can be found. If you have not done that before that may explain some of the reasons why you have variation in the casting slip from time to time.

I know of two or three instances where the selection of the china clay has caused a whole lot more trouble than the selection of ball clay. We have talked as though the ball clay were the principal place to find trouble, but I think you will find just as much or more, particularly in the heavy casting, in the china clay than you do in the ball clay.

C. C. TREISCHEL: It would hardly seem natural that an entirely different process from the plastic in which we utilize so much of the most minute particles in the clay substance would give a great deal of information or enough information to act as a guide for the casting process.

The Standards Committee have done nothing regarding the testing of materials for casting process, but as this process is getting to be such a big factor in the forming of whiteware in this country it seems as though we have some work ahead of us in the devising of standard tests for clays for use in casting.

C. C. ENGLE: Mr. Riddle, what would you suggest as a standard for use for comparing one clay with another, what amounts and what materials, to adopt as a standard of comparison for a lot of different clays, for example?

F. H. RIDDLE: Without having had an opportunity to give it any serious thought what I think I would do would be this: Keep a certain

amount of the materials that we know the exact content of and which have worked satisfactorily; make up a small amount of body from those materials with the exception of one of them which would be a new supply. For instance, if we wanted to test out the ball clay, we could make up the new body with flint and feldspar and china clays; then put in the new shipment of ball clay and test it out with a known specific gravity, varying the electrolytes and plot the curve for the viscosity. That would give an idea of the behavior of that particular clay and how it affected the body as a whole. If we find the curve running right along normally we feel pretty safe in casting with it.

C. C. ENGLE: I had more in mind this matter of testing the clay for its properties.

F. H. RIDDLE: The reason I brought it up that way is that the average man is interested in, not the clay by itself, but what it is going to do to the body, and that process would give that information. Some similar procedure would be used to test the clay by itself.

In our laboratory we have so calibrated the little mills as to grinding performance that we can in the small mill produce a body which can be duplicated in the six foot mill. It took a long time to determine the grinding schedule which would produce like results in both mills.

I realize that in the heavy clay ware where we are using car after car and the material comes in and is dumped into the bin that it is very difficult to do anything except to talk the thing over after it has happened. But by testing the clay occasionally, even if that clay has gone on into the bin, and a variation in the ware found, it pays to check back to determine the cause of variation. It pays to separate the clays more carefully or to hold them back until they are tested if this trouble is found too often. From time to time it is found that a clay will gradually change so that in a few carloads an entirely different amount of salts is being used from the amount used three or four months before.

E. H. FRITZ: We have not been able to devise a test for properties of clays which is satisfactory; that is, for casting, of course. We are working on that, however.

At the present time we are doing just as Mr. Riddle suggests. We introduce the clay that we want to test into our standard body, keeping all other things the same and then come to our viscosity limits such as we described in our paper[1] and cast with that a piece which is most sensitive to variations. That always is a piece with a very heavy section.

It is not necessary, however, to use a standard design. Any standard test piece can be used. But a test of this kind is the only test as far as I know that really shows the variation in the clays.

[1] E. H. Fritz, "Some Observations in the Casting of Heavy Electrical Porcelains." *This Journal*, pp. 547–54.

K. M. SMITH: If you do find something the matter, how are you going to fix it? Let us take an English china clay. Suppose we find it is off. Are we going to correct it by adding more flint? Suppose that it is cracking too much. Are we going to correct that by adding an inert substance like flint or something else?

F. H. RIDDLE: We know where to start and that is worth a great deal. It is good practice to use clays of several sources so if one goes wrong it does not have such a serious effect on the entire body.

E. H. FRITZ: Since we established our present casting control such as we described, we have not had any trouble whatever due to the casting behavior of the slip with ware less than four inches thick. We are only affected on the pieces heavier than that by variation in the clay.

A. S. WATTS: We want to begin to consider diagnosis very seriously. If people will do just as Mr. Fritz and Mr. Riddle have suggested, if they will diagnose the case carefully and find out where the fault is, then we can begin to take up the individual problems of how to treat the disease. I do not believe we shall get anywhere by the customary factory practice of saying, "Well, we changed kiln burners; that is the trouble; it is all on the kiln," or, "We have a new man in the slip house; there is the whole trouble; it was in the slip house." The result is that somebody else takes a mental vacation in the plant and as long as there is a new man in, he carries the load.

T. A. SHEGOG: In the general ware industry I think we are up against a condition which apparently we cannot very well alter. We have to use the same body for casting as for jiggering so that the body is at best a compromise. Very few of our plants are equipped to run with two different bodies. Very often we may know where the trouble lies but we can only ameliorate the condition; we cannot get out of it.

Question 12 What faults are caused by an increase in specific gravity of a slip? By an increase in viscosity? By a decrease in each case?

F. H. RIDDLE: Specific gravity and viscosity are supposed to be the very interesting properties of the slip. They are heart of the subject.

C. C. TREISCHEL: What will happen to the casting body in the factory if suddenly the weight of the slip goes up? What trouble is there? Is there balling, soft centers or cracking in the molds?

Many times it is good practice to know about these things before they happen, so if we get the slip that way we can expect trouble to come. I do not suppose any of us have slip that varies that way. Maybe it goes the other way. What will happen if it goes down? If we are running 32 ounces to the pint, suppose it goes down to 31 ounces, $30^1/_2$ ounces? What happens?

W. L. SAMPLE: We had a peculiar experience recently. We get the specific gravity of our slip by measuring in a bottle. Somebody switched bottles on us, the specific gravity went up, the weight per pint went up an ounce and a quarter and the slip got rather thick and would not drain very well. It was not as good as our regular slip. It did not make much difference apart from the slowness of draining. We do not take much stock in the specific gravity or viscosity reading. We have a viscosimeter but it is rarely used.

They have been making slip at our plant at Newcastle for more than ten years and they never bother about the viscosity determinations. They just pour a little slip in the mold and cast with it. The results are quite satisfactory. But to come back to the question: increasing the specific gravity *per se* makes the slip so that it does not drain well. A definite viscosity reading has nothing to do with the way the slip will cast. The way the slip will cast will have something to do with the viscosity, but I have not been able to get any check on it. Viscosity is one thing one day and another thing another day. I do not care about the viscosity except incidentally.

C. B. YOUMANS: We find that the weight does not vary a great deal, but we do find that the viscosity will vary, and if it does it will give us trouble. Our tank men like a very much more viscous slip than the wash down men. We have only the one to supply both men. We do not have to vary the weight at all; apparently, it does not seem to make much difference. The viscosity gives us a great deal of trouble. We are more interested in viscosity than in specific gravity.

K. M. SMITH: I ran some tests on viscosity and found a variation of 15 to 20 seconds, which I thought was very bad. That was for 100 cc. After hearing some of the discussions that were brought out yesterday where one man allowed two minutes, I do not believe ours is very far off. It will not vary more than 25 seconds, so I think one reason why we are not having any trouble as far as viscosity is concerned is because it stays within that limit.

C. B. YOUMANS: Ours is 200 cc. That will make a difference. You only have a hundred.

K. M. SMITH: We could use 200 cc.

C. B. YOUMANS: You will find it different there.

E. SCHRAMM: What is the size of the outlet?

C. B. YOUMANS: It is the standard size.

E. SCHRAMM: The ordinary viscosity test is one in which a can of some kind is used and the slip is allowed to run out. We find it more convenient not to let the slip drain completely, but simply to run into a graduated cylinder a volume considerably less than the capacity of the can, so that the test is not complicated by the extremely slow delivery towards the end.

F. H. RIDDLE: It might be of interest to know that we have a Bureau of Standards viscosimeter made of copper. We made a good many tests, particularly on glaze. We made one out of aluminum so that it would be lighter for the girl to handle. The difference was very marked between the speed in the copper and aluminum viscosimeters. When we talk about viscosimeters we are talking about wide variables.

W. K. MCAFEE: Much of this apparent dissention on viscosity, and differences in specific gravity, depends on the skill of the men using the slip. Experienced casters can handle a thick slip one day and a thin slip the next. In other words, they carry a pretty good viscosimeter in their fingers. They can tell by the "feel" of the slip.

An increase in specific gravity will slow up the draining and in some of the complicated pieces may cause hanging and trouble of that sort. A decrease will possibly give more trouble than an increase due to excessive shrinking.

C. C. TREISCHEL: There are many different things that are used to test viscosity—all the way from sticking our hands in the slip up to machines that cost $200 to $300. We shall never reach a conclusion if we talk viscosimeters. No matter what type we use we can get a working curve showing the viscosity of the particular body that we are using. The curve which was shown on the sheet yesterday in the slide by Mr. Sanborn is something of that sort. Suppose we are working in the range, *a*–*b* (Fig. 1) that is our limit. What will happen if the slip does not flow as fast? Suppose we are above *a*. What will happen to the slip? That is what we want to get at in this question. What will happen if we get down below *b*? We know that settling will occur if we get below *b*. We get thickening above *a*. I do not know what trouble that will cause in casting. A slip will thicken on standing and thicken rapidly if it is near the range *a*–*b*. If the workable range on a body runs from *a* to *b* it will cast faster at *b* than at *a*. I know one man who uses that for control. He has a body which if deflocculated in the ordinary way would cast so fast that his men could not keep up with it. So instead of varying his clay for control he controls it by alkali and stays near *a*. He has a very thick slip which is viscous but not heavy. It does not flow well. Can someone tell us what would happen in casting, if we get up above *a*?

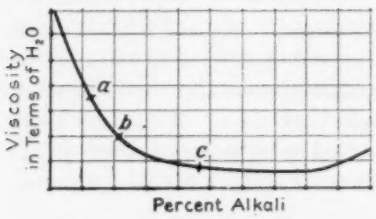

FIG. 1.—Casting discussions.

P. SANBORN: If we get up above the second line, the ware when it is cast will act quickly, but when we take the ware out of the mold or take the mold away from the ware, (sanitary ware) it is not solid. The ware

will have a tendency to settle down, that is, if accidently bumped it will tend to warp without cracking. The pan of a bowl will settle and if propped up it will dry perfectly straight. When it comes to the inspectors they will not see anything the matter with it. The only trouble is that invariably when it comes from the kiln it will be warped just precisely as it was warped in the green stage.

K. M. SMITH: Do you find when you get over to the right side of the curve that it is over-doping the slip? If the cast, taken between your fingers, is brittle and hard when squeezed or pressed together it will cause cracking in drying before you can get the molds away from it. While if you stay on the left hand side of the curve (if you get high on the curve) your ware is jelly-like. It is very soft and quite plastic when pressed in the hand. I do not know whether that is due to the sodium carbonate or silicate. The general opinion is that the hard feeling body is due more to the sodium carbonate than to the silicate.

C. C. TREISCHEL: It seems to me that comes from a question of the difference between clays which are flocculated and those which are deflocculated. At the right of *c* you have a flocculated condition which is entirely different than where it is deflocculated left of *c*. The material in the clay is in an entirely different state.

Question 13 How can we account for differences in viscosity from time to time at maximum deflocculation and constant specific gravity?

C. C. TREISCHEL: Suppose this is the curve (see Fig. 1) of a body that is worked at 32 ounces to the pint, and we are working in the range *a–b;* and to get a flow corresponding to 32 ounces to the pint, we should have to add considerably more alkali.

It would seem that we have not in any way changed the clay content of the body because the specific gravity of the casting slip depends entirely upon the amount of clay and inert materials and water. If that is constant we have every reason to believe that these conditions are constant. Still, it takes more alkali to give the same rate of flow. That is the question as it was explained to me by the man who proposed it

Will variation in temperature cause that? It is a thing that is likely to happen more in the winter than in the summer, especially on Monday mornings after the casting shop has cooled down over Sunday. What other things would cause it? Will the variation in the ball clay cause it? If so, why? Will the variation in the size of the grain of the flint cause it, or feldspar?

W. K. MCAFEE: I believe it is a practice in some of the European plants to actually age the slip after it is made. That is more or less allied with this question. I wonder if anybody in this country is trying that?

K. M. SMITH: It was brought up in Mr. Sanborn's paper that after aging four days the viscosity was lowered appreciably without any changes being made in the actual content of the slip.

C. C. TREISCHEL: That was in connection with a different sort of deflocculating material than most of us are accustomed to using. The material he was using for deflocculation was much slower in its action than soda ash and water glass.

K. M. SMITH: From the discussion of Mr. Sanborn's paper it developed that the organic deflocculating agents came from the ball clay. Four days of aging seemed to be the maximum time the slip lowered in viscosity and yet stayed constant in weight. After the four days the viscosity did not decrease any more. He explained that as being due to the organic deflocculating constituents from the ball clay.

C. C. TREISCHEL: I am afraid that you misunderstood part of Mr. Sanborn's statement. What I brought out from him was this: if at *a* on the curve, as the slip ages it comes down to *b* and he then casts it, this, *a*, was 125 seconds flow and *b* was around 108. Point *a* is the place where the slip comes from the ball mills and goes into the aging tanks. It then is allowed to age down to *b*, when it will run steady. On further aging it will start to thicken. That means that it comes down to a point where he gets the maximum effect from the deflocculating material and then the slip starts to thicken up due to adsorption of this deflocculating material.

Mr. Sanborn did not say that he uses soda ash or sodium silicate as his deflocculent. He said that he determines whether he is on the right or left of *c* by adding sodium silicate to his slip to test it. If it gets thicker he knows that he is on the right side, if it gets thinner he is on the left of point *c*.

Question 14 Do all body mixtures have the same relation between specific gravity and viscosity to produce best results in casting?

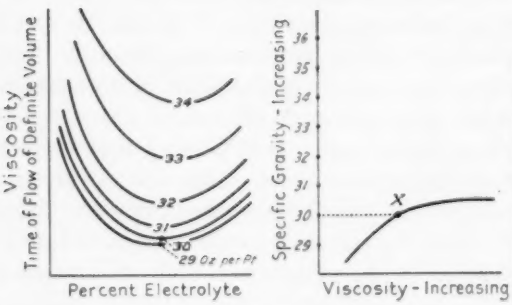

FIG. 2.

W. K. MCAFEE: This is rather a deep question to answer offhand this way and I should suggest that some of us obligate ourselves to take the bodies, make this curve as you suggest there, and send them to a clearing house to see how near alike those curves are; whether or not they do follow the same form. They might then be referred back to each of us to see what results we could get with specific gravity determined in that way.

I do not think that we can answer it here, but we can make plans to answer it in our own plants.

Question 15 On what property of a casting slip have we the greater percentage limit in variation, specific gravity or viscosity?

C. C. TREISCHEL: This question has been answered above.

Question 16 What causes the formation of a definite skin of fine clay on the surface of a cast piece? This skin fires a darker color and is extremely vitreous.

That question came all the way across the Atlantic Ocean. If any one has anything that will answer it I know our friend over in England would be glad to hear what we think about it in this country.

C. B. YOUMANS: We would say it was too much soda.

A MEMBER: The clay will go to the surface. If we have a surface of clay it will naturally vitrify a little but quicker than the center of the body. We experimented on heavy clay products. The other day we used a little sawdust. This was in the center and we had a hollow piece when we got through with it. The sawdust burnt out and showed practically all clay on the outside.

H. GOODWIN: It is affected by the way the caster fills his mold. There is an alkaline content which comes to the surface which affects that skin there.

T. A. SHEGOG: Are you referring to the brown stain that forms where the slip drops in the mold?

H. GOODWIN: I have had about 17 explanations of them but none of them have been very convincing.

C. C. TREISCHEL: Mr. Shank of Shank and Company, Ltd. has asked this question. He refers to that idea of the slip striking the mold, but that does not seem to be where his trouble is. He states, "We have sometimes been troubled with scumming or rather the formation of a definite skin of fine clay on the surface of the cast piece. This fires a darker color and is extremely vitreous. We have the same phenomenon where the slip first strikes the mold, occasionally spreading to a considerable area and accompanied by blue stains. These are fairly common in cast ware, and, of course, show up very much more in the case of a vitrified piece."

T. A. SHEGOG: The phenomenon is perfectly common, and although I would not like to venture an explanation as to what is the cause of it, it has been discussed for many years. I can tell him how to stop it, if that is of any assistance.

It usually forms about as big as the palm of the hand, perhaps about the size of a half dollar, just where the slip strikes. If the slip does not strike it will not form, so I have stopped it within the last couple of years by

letting the slip fall on a brass plate mounted on three little legs, so that it strikes the brass and spreads out. In sanitary ware you can stop it by having a bent tube and pouring through the bent tube, with a funnel, so that the slip rises in the mold instead of striking the bottom in falling. Either way will stop it, but I cannot tell you the cause of it.

W. K. McAFEE: Not only the striking in the bottom of the mold will give a streak, but an appreciable striking of slip against the mold after the slip is actually in the mold and the mold is pretty well filled up, also gives a streak. I did not understand that that was the problem in this question, but I am glad that it is because I never have heard any explanation of that streak, either. The only way that I know of to prevent it is to keep the slip from the side of the mold as long as possible, *i. e.*, to have it rise uniformly from the bottom.

C. C. TREISCHEL: Filling the molds from the bottom will remedy it.

W. K. McAFEE: In casting closet bowls we fill the mold from the bottom. In going to the bottom the slip has to pass through a small hole in the trap. Of course, we are using the overcast method where the trap is cast the day before and we pour the slip over this trap. The trap has a small hole in the bottom and if the caster pours the mold too fast the slip will overflow the trap and strike the side of the mold. Invariably we get a brown streak which burns blue where that slip runs over the side of the trap. We provided the casters with pouring troughs with an orifice of a fairly accurate size so that it is impossible to pour too fast.

Question 17 What are some simple, reliable and rapid methods for measuring viscosity of thick and heavy slips?

C. C. TREISCHEL: This question also comes from abroad. Evidently what the gentleman had in mind is the measurement of the viscosity of slips which are too thick either from being too viscous or of too high a specific gravity to flow through viscosimeters of the ordinary flow type where we stay below a quarter of an inch orifice. Has any one had any experience with the tortional type of viscosimeters? Has any one used a viscosimeter with an orifice of half an inch or more, holding a gallon? I know Mr. Bowman has.

W. J. J. BOWMAN: Our method is not a very close measurement. We use a U-tube, $^1/_2$ inch in diameter with a funnel attached to either end of the U-tube. We fill the one funnel with a given quantity of slip and take the time required to rise to a given height in the other funnel. We have found when we weigh a pint of slip and make slight addition of water to the blunger we could not detect (by weighing another pint of slip) any change in weight, but there would be a change in the reading of the viscosimeter.

C. C. TREISCHEL: Does the instrument work all right for the body for which it is devised?

W. J. J. BOWMAN: We have been using it for years. We know that when the slip rises in the funnel of the viscosimeter to its level in a given time it will work in the mold all right.

C. C. TREISCHEL: One man asked me if anyone had had any experience with viscosimeters for use on casting of grog ware, such as the fire clay sanitary ware, sometimes called solid porcelains. What do they use in that industry?

W. J. J. BOWMAN: That is what we use it for.

Question 18 Why is it that two mixtures will give slips that apparently cast and work the same, yet one will be full of "pin holes" and the other perfect?

C. C. TREISCHEL: This question has been asked by a man who has given us a large amount of information on pinholing. It ought to be a good idea to reciprocate.

Will the rate of flow have anything to do with that? The slip that is fluid certainly should allow the air to escape from it more readily than one that is thick and viscous.

H. GOODWIN: Have you seen that interesting discussion which took place in the English Ceramic Society on "Pinholing?" A short abstract follows:

In the course of his paper, Mr. Plant outlined numerous possible causes for this aggravating fault, which revealed itself in pottery production with such disastrous results, financially and otherwise, to the manufacturer. One local pottery manufacturer had estimated that his loss, through this cause alone, amounted to no less than two thousand pounds in a period of about twelve months, while every manufacturer encountered the fault in a greater or lesser degree.

The Causes of Pinholes A case was cited of one manufacturer who was making a very fine line of under-glaze hand-painted pottery. A special palette of colors had been prepared and business was booming, the results, from a productive point of view, being excellent. But, all of a sudden, pin holes developed on the surface of the finished ware. This resulted in a very large percentage of seconds, 30%, at least, of the goods coming from the ovens faulty. All sorts of investigations were made with a view to putting a stop to the trouble. Special precautions were taken in the sliphouse; the glaze was brought under suspicion; experiments were made with other glazes; and then experiments with other colors; but although some improvement was made by fluxing of the colors, the loss still continued, until it became almost impossible for the works to deal with the orders on hand. Meanwhile, months had passed in this effort to trace the cause of the trouble, and, as so often happened, the remedy was the simplest possible. Instructions were given that the biscuit ware before being decorated, should be washed in clean water. Immediately, the pin holes disappeared, and up to date there had been no further trouble in this direction.

But there were numerous causes which led up to pinholed ware, and these the essayist proceeded to deal with individually, summarizing them as follows: Imperfect

preparation of materials or clay; imperfect blunging; insufficient aging; faulty pumps, pumping air instead of clay; bad pugging; unsatisfactory press cloths; dust on the molds; perished molds; too much water used by the potter; cast mold being too wet; too dry or too hot; bad firing; and faulty glaze mixing.

E. H. FRITZ: Do you mean by pinholing the imperfection on the glaze surface only?

C. C. TREISCHEL: I think that is what they refer to.

E. H. FRITZ: That is not the term we use. I might be able to give something that might help you.

Our product, of course, is a one-fire proposition. We have found that we could not do any sponging on the ware without getting into this pinholing. We finally had to adopt the following procedure.

We blow the ware using an air pressure of about 40 pounds, removing all dust in that way, and then we spray the glaze on, but not necessarily the whole coat. We usually dip the piece of ware after it has been sprayed. By spraying we get the glaze into pits and crevices which have been uncovered by the air and were filled with dust. These pits are usually due to air in the slip.

The air, therefore, serves not only to remove all dust on the surface of the ware, which is very essential, but also to uncover the pits and crevices which are always present and are filled with dust. If we only sponge, we leave the dust in these pits and later glaze over it which will inevitably cause a pinhole. So I think we have found the answer in our cast ware at least.

W. K. MCAFEE: I think this whole question of pinholing is probably complicated by the fact that we are trying to include too many different faults under the term of pinholing. Some pinholing comes from air. I have seen strong evidence of what is apparently pinholing due to the glaze. Probably they are two different faults that look alike. . There may be some more faults, which we call pinholes. Some of them may be due to shrinkage on a green piece and may not be air at all.

T. W. BLACK: I had some trouble with pinholing that occurred in the decorating kiln. We had no trouble with pinholing after it came out of the glost kiln but after it was decorated it developed. How do you account for that?

H. GOODWIN: This result could be obtained by too great a temperature in a decorating kiln, in comparison with that of a glost kiln and not be termed spit-out.

EDITOR: Pinholing in decorating kiln often is due to carbon particles which were covered, the ware not being cleaned.

Question 19 What are the possibilities of the casting process in the manufacture of saggers?

C. C. TREISCHEL: Mr. Morris, could you tell us what the possibilities are?

G. D. MORRIS: I think that we are getting considerably better saggers today.

Two years ago we made up some cast saggers for a company using a Dressler kiln. They still have the same saggers with about 10% loss. I think Mr. McAfee can give you some information because they are making cast saggers and have been using them right along. Of course, we are making a large number of large slabs, and in comparing them with the pressed slabs, we find that they have a life in the tunnel kiln of about three times as long.

W. K. MCAFEE: I do not have any exact figures, but we get a considerably longer life out of cast saggers than we do out of hand or machine made saggers. We try to place cast saggers at the bottom of the bungs to build from. They remain much straighter and make a better foundation, are stronger and we feel a little bit more safe in starting the bungs off.

We subject saggers to about the same conditions as everybody else. We have not done a great deal of work on this. Apparently, a small percentage of carborundum in the cast sagger mix will further increase the life of the saggers. We probably do not put enough in to increase their conductivity but apparently this makes them a little bit stronger. The behavior of the mixture in the casting, as suggested a while ago, is advantageous. You have a mixture of clay slip and grog, with the grog in various degrees of fineness. The clay mixture will go to the outside and form a sort of skin. The grog particles will arrange themselves more or less with the finer particles toward the outside and the heavier particles in the middle. That gives a very nice structural shape. It comes automatically.

F. S. CRUMLEY: Mr. McAfee, do you use the same mix for casting saggers as you do ordinarily?

W. K. MCAFEE: No.

W. J. J. BOWMAN: I have not had experience with saggers but for a muffle kiln. We had a better shape rather than a more refractory piece in our case.

W. K. MCAFEE: We found that a small percentage of the native red clay down near our plant will materially increase the mechanical strength of the sagger which, of course, is an advantage because that is where a lot of the sagger loss comes, handling them while they are out of the kiln. We find by adding a small percentage of that red surface clay that we get a tougher sagger which does not break so easily mechanically.

R. E. ELLIOTT: I visited a plant where they kept the slip quite warm, which was a new thing to me. What is the point in having the slip heated?

G. D. MORRIS: You do not want to use warm water. It is all right to keep the slip at a warm temperature, but if boiling water is used and that goes into the mix there will be trouble. It is all right to keep it lukewarm.

C. C. TREISCHEL: Two men who have had considerable experience in casting have told me that that is the best way. They passed live steam into the tank of water. It was stated that the water was almost to the boiling point when the clay was added and allowed to stand overnight, just soaking with the salts, and then stirred up in the morning.

G. D. MORRIS: You will have to dissolve the soda in hot water. It would work much better to do it that way.

Question 20 Are there any deflocculating agents in practical use other than water glass and soda ash?

CHAIRMAN TREISCHEL: There are two materials of an organic nature which have been used to my knowledge. One is gallic acid and the other is extract of tannin. Has anyone here had experience with those materials? It was mentioned last year at the meeting at Atlantic City by one of the men from the Bureau of Standards that they were experimenting at that time with the use of gallic acid in connection with deflocculating a grog body for casting glass pots.

C. B. YOUMANS: We tried a little of that. It is very active much more than the salts.

K. M. SMITH: It seems if something of that kind could be used we could get away from this skin that we are talking about on cast ware and would help our glazing trouble. It will give us a better bond between the biscuit and the green glaze before it goes into the kiln. I think it is well worth investigating.

Mr. Sanborn has used a considerable number of those organic materials in an attempt to find out an organic material which will act the same as the material which he is using from that ball clay he referred to. He has tried tannin and a lot of tannery extracts.

C. S. MADDOCK, JR.: Gallic acid will produce a skin that is very hard.

E. H. FRITZ: Has it ever been found out just whether this skin that forms from the use of the common deflocculents, especially water glass is not dependent upon the amount that is used in the body? We never encounter that, but our amount, I imagine, is rather small as compared to that used by others. Ours runs around .2 or .1%.

C. C. TREISCHEL: On the basis of the materials as received or based on the Na_2O content?

E. H. FRITZ: The per cent of water glass added is .2% of the entire mixture. It seems to me that the fact that we do not encounter this trouble must be due to using such a low amount. If that is the case, the answer is to develop the body in which higher amounts are not required.

Question 21 In connection with water glass, what ratio of Na_2O to SiO_2 gives best results? Will this vary according to the types of clay used?

C. C. TREISCHEL: Mr. Rhead asked this question. Has anyone had any experience with changing the water glass that they use from one specific gravity to another? How does that affect the slip?

C. B. YOUMANS: We had that experience. We use silicate of soda for our sagger cement also, using the U-brand for casting and the N-brand for making sagger cement. Due to a slip-up we got hold of the N-brand used for making the sagger cement and used it for the regular casting slip. The minute that happened our slip was thrown completely off. We find the U-brand is much better to use than the other.

C. C. TREISCHEL: When this mistake was made, how did it affect the slip? Did it become thicker or thinner?

C. B. YOUMANS: It was thicker. The N-brand did not have the deflocculating properties that the U-brand had.

C. C. TREISCHEL: Is the U-brand thinner or thicker than the other?

C. B. YOUMANS: Thicker.

W. K. MCAFEE: If we adjust the different brands for the actual specific gravity and vary the quantity according to the specific gravity, they will work about the same.

C. C. TREISCHEL: There seems to be a great deal of difference of opinion on the effect of some of these things, as I have talked to men around the country. One man will use soda ash, another man will use salsoda. He will say it is better in a hundred ways than soda ash, while it is nothing but soda ash with but ten molecules of water tacked on to it. He says it is better for deflocculating material.

Is it just a matter of opinion? Some one will use soda ash and get along satisfactorily and somebody else will use sodium silicate and get along all right. Another man in another part of the country will probably use salsoda mixed with water glass, half and half, and he gets along all right. Is it a question of having the right deflocculating material for the type of body or just a matter of opinion?

R. E. REIF: If I recall correctly, over in Germany there are some potters using nothing but soda for deflocculating agent, using it as sodium oxide, so it must be due to the water content.

D. R. KELLOGG: In comparing these various deflocculating agents are they all figured back to the same hydrogen-ion concentration? It seems to me as a chemist that is the secret of the whole thing. Some work done at our laboratory seemed to indicate that the hydrogen-ion concentration was an important thing. I have been wondering if these stories as to various brands of soda ash and salsoda, etc., have ever been compared on the basis of the actual hydrogen-ion concentration.

E. H. FRITZ: We have never actually determined that, Mr. Kellogg, but from my observation it is absolutely correct. It is entirely a function of the hydrogen-ion concentration.

When we first started to cast we used sodium silicate and sodium carbonate. After a while we decided that if possible it would be nice to eliminate one of them, especially the carbonate because the silicate is so much easier to handle in the liquid state. We did that maintaining the same Na content and we could not see any difference in the results.

E. SCHRAMM: I think there is no doubt that the question of the hydrogen-ion concentration is the important thing to be considered with any one deflocculating agent but sodium silicate has a much stronger deflocculating action in equivalent proportions than carbonate.

Our practice is to use sodium carbonate for the greater part of the deflocculating agent and sodium silicate as a control because of its extremely powerful action in small quantities. We vary the proportion of alkali from time to time and control our slip in that way. In other words, we use the silicate to take care of the variation in our conditions.

K. M. SMITH: Is it not the function of the sodium carbonate as a deflocculent to act as a hardener for the cast ware?

That seems to be the prevailing idea among the old potters and the men that have been in the plant where I am. They seem to think that if we do not have the sodium carbonate in there the ware will remain soft. The sodium carbonate hardens the cast ware so that the molds can be taken apart.

C. C. TREISCHEL: You mean that you can cast faster?

K. M. SMITH: Not so much in casting speed but in hardening the ware after it is cast, so that the molds can be removed sooner without the body remaining jelly-like.

T. A. SHEGOG: I found the sodium carbonate used in another way. Once in a while the cast piece showed a marked tendency to stick to the mold and it is difficult to remove. In those cases I have found that if we substitute a certain proportion of carbonate for the silicate we get over that sticking. That is particularly noticeable in casting handles. Sometimes they will not come out of the mold readily, and then each individual handle breaks off, but if we replace a certain proportion of the silicate with carbonate it does not stick to the mold nearly so much.

H. GOODWIN: I quite agree with Mr. Shegog.

PAUL TEETOR: Much depends upon the properties of each combination of clays. In some cases the ratio of sodium carbonate to sodium silicate can be varied over a wide range while in others it cannot. I have in mind a combination of clays which when made into casting slip with sodium carbonate in excess of sodium silicate will cast satisfactorily but the piece will not harden sufficiently so it can be removed from the mold the

following day; in fact a little jarring will cause the piece to collapse and form slip again. If this same body is made into slip with the silicate predominating it will cast and harden as desired.

It is not always just a case of adding the proper amount of either of the salts but in some cases the properties of the materials have to be considered and the ratio of the two salts adjusted accordingly.

Question 22 What practical method could be adopted to test each batch of casting slip before it is put into use?

C. C. TREISCHEL: Has any one used that system or process? Some of the men here use it because they have so stated.

W. L. SAMPLE: We always pour a little slip in a mold and test it. It does not take very long. We are up against it for time. We have to make slip as fast as we can, and when the slip is blunged sufficiently we start to let it out and make a test at the same time, and if necessary we add more deflocculent while the blunger is being let out. I heard the remark made yesterday by someone that they did not have time to test each batch of slip. I do not find that it takes long.

Question 23 To what extent are casting problems concerned with the type or quality of plaster used in making molds?

C. C. TREISCHEL Does the type or quality of the plaster we use in the molds make any difference in the result obtained? For instance, in sanitary ware casting do any of us use the same plaster that you use in the terra cotta industry?

E. H. FRITZ: We had a rather interesting experience a few weeks ago. We found that we could use a greater ratio of plaster to water in making molds, which is desirable in the plastic process where the molds are given very rough usage. Unfortunately, we did not take into consideration what effect that would have in the casting molds and naturally the molds were made up the same way from the heavier percentage of plaster. After we put them into use we noticed that we were getting a considerable amount of pits or pinholes in the pieces after they were cast. We finally found that this was due to air actually coming out of the plaster. It seems that the air instead of going out of the plaster at the top of the core as it had been doing, crept out through the side of the core into the slip and was trapped there, causing pinholing. The cast of plaster was evidently so dense that the slip offered less resistance to the air when it was forced out by drawing water from the slip. When the less dense plaster cast was again used, the trouble immediately disappeared.

W. K. MCAFEE: A great deal of that is up to the mold maker. If he allows the plaster to set a little bit too far before he pours the mold in the cast, he is likely to get more of a tendency to produce pinholes in the finished ware.

GEO. CARTWRIGHT: I spent four or five years on that work myself. The trouble I have found is that they pour too many cases from one bucket of plaster. Eighteen or twenty cases out of one bucket of plaster cannot be poured and produce good ware. If 18 cases are poured, the first six cases will be hard and the next six molds may be fairly good, while the last ix molds will be soft.

We find that we get a great many pinholes in casting if we use the molds too long. As the molds wear we all know that they go to pieces, and when we find that they have a pinhole there will be a pinhole in the piece of ware nine times out of ten.

C. C. TREISCHEL: Has anyone had any experience with mechanical mixers for plaster?

E. H. FRITZ: We use the mechanical mixer in our work entirely. We have found it to be superior to the hand method of mixing plaster. It is a very simple proposition and is very much on the order of the mechanical mixer for cement. The spindle revolves at the rate of 250 r.p.m.

We have incorporated this method in our process specifications for making molds. Since the time we have adopted it we have found that our molds have considerably longer life and are very much more uniform.

C. B. YOUMANS: We have just started to do that in our mold shop and find it superior to hand work. We have a machine manufactured by the Hobart Manufacturing Company, Troy, Ohio. It is a regular dough mixer but we have adopted a special paddle to mix plaster.

K. M. SMITH: How do you test plaster to know when it is ready to pour?

C. B. YOUMANS: We have a regular kettle as ordinarily used and by placing your hand in it you can tell, just as in hand mixing.

E. H. FRITZ: I can answer that. Try various times of mixing and see what kind of a mix is obtained. You can very easily tell when you have mixed it too long from the way the plaster slip will pour. After the proper time has once been determined, standardize on that.

C. C. TREISCHEL: Has any one established standards whereby plaster and water are weighed?

E. H. FRITZ: We have done that.

C. C. TREISCHEL: Does that make any difference?

E. H. FRITZ: That is just as important as the mechanical mixing. The trouble which I described a few minutes ago was due to using too much plaster in the mix. It is all covered in our specifications.

W. K. MCAFEE: With regard to weighing the plaster, our molds are comparatively large and we only pour one mold or two halves of the same mold probably from the same kettle of slip. We use scales to get the proper amount of plaster to put in and the amount of water for a 2:1 ratio.

T. W. BLACK: The addition of marshmallow root helps to harden it

and retards the setting and solution is made by boiling the root in water and adding to the mix when cool.

Question 24 What is the best practice with reference to mesh of lawns in preparing casting slips for various purposes?

C. C. TREISCHEL: Does that refer to pre-mixed or raw slips, or both? How about the size of lawn that is most satisfactory for raw slips, slips which are not made from filter press cakes or from pug mill blanks but are made from the raw materials. Can they be lawned through a 140-mesh? Do they have to go down to an 80?

W. K. MCAFEE: In order to start the discussion there are two general methods of making slip which will bear discussion. There is the raw method and the method with the filter press cakes.

We like to blunge the slip twice, principally because of this question of lawning. We make the slip up the first time about 20 ounces to the pint in order to get through a 120-mesh lawn. We pump part of that through a filter press and introduce it into the second blunger. We then mix the cakes from the filter press with this thin slip in order to bring the slip up to our finished weight of about 29 3/4 ounces. This finished slip will go through a 90-mesh lawn. If we mixed it all at once I do not believe we could get it through anything finer than a 90-mesh lawn. By the two methods we get it through 120, and we feel that we get a much cleaner body.

W. K. MCAFEE: The slip runs through the lawns too slowly to be practical.

C. C. TREISCHEL: Is not ball clay usually the thing in the body that makes it lawn harder? Has any one tried to wash the ball clay and use it in slip form in the mix?

K. M. SMITH: I have tried washing ball clay for a laboratory test and I found it quite difficult to put it through 100-mesh lawn. I ran it through the biggest series I could and tried to get as much out as I could before it reached 100.

C. C. TREISCHEL: This system is actually being used in plants. In that way they remove in a preliminary way a considerable amount of the material which causes the lawn to plug up. It is working very satisfactorily. I know of two cases where it is being used.

There is another thing in connection with that method that we want to consider and that is the fact that we can make the ball clay slip to a certain specific gravity and in that way insure a greater uniformity in the constituent which plays such an important part in the casting body. It is a means of control as well as one of cleanliness.

K. M. SMITH: Is it not true that the black ball clays will vary quite a lot in their lignite content? The point was that it would standardize the ball clay to a better extent.

W. K. McAfee: It eliminates the much harder question of water content.

K. M. Smith: What size mesh screen would you recommend for the final screen?

C. C. Treischel: It depends upon the subsequent treatment of the body. I know of one ground body that is made from the raw material that is screened through 180-mesh lawn. They are casting slip. I also know of a number that screen through an 80. It depends upon the preliminary treatment.

Question 25 What is the rôle of halloycite in casting? Does the use of it under certain conditions lead to troubles in mixing, casting and in firing? (This question comes from France.)

F. H. Riddle: I imagine most of us have at least seen halloycite. It has a hard surface and is white like kaolin, waxy and very hard. It will not slake down so readily in water and you practically have to grind it.

Naturally it has a high shrinkage and it is more colloidal. When it is worked it is very fine and spongy, and I imagine it would be useful in the same way that bentonite and some of those other materials are.

No one has mentioned this material as an aid in casting. It would be worth while possibly to try these things out. Halloycite can be obtained in the States because we have some of it in Detroit.

K. M. Smith: Prof. Cox, from whom I received my training, has done some very remarkable things with bentonite. I used about 5% of it with calcined china clay and ground it in a ball mill, enough to blunge it. I found that it would cast very well all alone and the resultant cast was quite hard.

I also took some grog made out of the dust from our sagger room, added some bentonite to it (about 5%), ground it in a small mill, and it came out like jelly. The large particles of grog would stay on top. They remained there until it hardened. It shows some wonderful possibilities not only in bodies but it is going to be very valuable as a floater in glazes that are high in frit, where we are having trouble with settling.

D. R. Kellogg: I heard somebody speak of that the other day and I believe they stated it was all tied up in patents. Do you know if that is true?

F. H. Riddle: There are a couple of patents which have been taken on it. One is used in spark plugs, I believe. McDowell has a patent on using a percentage of that. And then a concern of consulting engineers in New York has developed or control patents on its use in certain ways. I do not think the entire field is covered, however.

D. R. Kellog: It is used for many other things also. It is pretty

well covered in soaps, etc., and as a suspending medium for flame-proof varnishes, etc.

F. H. RIDDLE: Part of ceramics is covered. The enameling people are using it in floating some of their enamels.

T. A. SHEGOG: I had something to do with Texas kaolin which is halloycite in nature. It would not slake in water at all even on prolonged boiling. If it is ground up with the mix, the mix cannot be lawned. The only way we could make up a body with it was in the ball mill. The body I made had 60% of English china clay replaced by this Texas kaolin. I added the non-plastic materials to the Texas kaolin, ground them separately and then ground the other plastics, the English china and ball clays. Then I mixed the two together, having lawned them separately first. The floating powers of Texas kaolin are extraordinary. After leaving that mix quite dilute for three days, intending to take off some of the water, I found that there was not any to take off. There was no sedimentation whatsoever, so that it has wonderful floating properties.

W. K. MCAFEE: Did you try to pump that or put it through filter presses? I understand it is very hard to work.

T. A. SHEGOG: You cannot put it through a filter press. It has been tried. A member of the committee who was carrying out these experiments tried that and failed utterly.

Then some one mentioned the casting. A body such as I have described can be cast but not commercially. It requires about three times as much water as an ordinary casting slip to get it into the liquid state and about two and one-half times as much dope. Furthermore, after it has been stirred up vigorously for an hour or two it thins up and can be cast, but it becomes entirely solid in the mold. To drain the mold it must be shaken vigorously, when it becomes fluid again and the surplus can be poured out. It takes about ten minutes to set up.

The pouring can must be shaken vigorously to pour another mold because it has become solid in the meanwhile. When all of these details are watched we get a wonderfully beautiful velvet finish on the ware. The feel of it is finer than anything I have ever seen. However, it is utterly uncommercial in large proportions.

E. SCHRAMM: I have made some experiments in connection with the same coöperative investigation. We were making vitrified ware. The body contained a replacement of 50% of English china by Texas kaolin. We did succeed in filter pressing it in an experimental plant, but I would not undertake to do it in a commercial way. I did not attempt to cast that body at all.

Following that up it appeared to me that the material might have some possibilities used in smaller quantity, so I made some pieces in which we got the Texas kaolin down to 5% of the body and made some casting slip

with that. And even in that small proportion this material had a remarkable effect on the casting slip. I had to get the specific gravity down to an abnormally low value in order to bring the viscosity down to any practicable pouring point. Even so we did not get the viscosity down to that of our regular slip. The behavior was just as Mr. Shegog describes, very slow in setting, but giving a beautiful velvety cast and a piece which finished very nicely.

Question 26 What is the best method of plugging drain holes in the hollow cast ware?

W. K. McAfee: What I had in mind in that was in the case of hollow portions, that is thick portions of the ware, it is sometimes advisable to drain and leave hollow. Of course, there is a hole through which you drain it. For commercial reasons it is advisable some times to plug the hole.

I had in mind the hollow corner of our sanitary tank. We do not have a thick section there. We have a hollow at each corner of the tank plugged in the bottom. We find this more or less troublesome, sometimes causing cracks. Sometimes it will go through the biscuit kiln all right and crack in the glost kiln.

We have tried two methods of plugging. One is to use pugged clay of the same body taken from the filter press and pugged and used in a thoroughly moist state. We have also tried pouring in a little bit of slip against the plaster of the block in order to let it set up in the hole with the idea of getting a more homogeneous body. The casting method of plugging the hole did not seem to have any advantage at all over the sticking up method. Both gave us a little bit of trouble from time to time.

T. A. Shegog: We had that some time back in plugging handles of cast ware. I found that using the ordinary scrap but loading it first heavily with flint overcame that. It only occurred when the plug was pretty big. We worked it in by hand.

G. Cartwright: I think if there are any cracks, the air behind the plug causes that. Take a handle for instance. If we do not make the plug with a dull point we shall have air behind it and it will crack every time. If we make it into a point it will not crack around or across.

W. K. McAfee: What do you mean by "air behind it?"

G. Cartwright: If the hole is not completely filled with clay it will have some air in it.

W. K. McAfee: The hole goes through a body about half an inch thick. I do not believe you get our problem. You are talking about general ware and I am talking about sanitary ware.

T. A. Shegog: In the handles I referred to we only plugged one end. The handle is hollow right through, so there is no air cushion back of the plug to push it. I regarded it as due to the rate of contraction.

G. CARTWRIGHT: What did you use for the plug?

T. A. SHEGOG: We used the scrap clay. I am speaking of cast ware, of course. The plug was dipped in water so that it was really softer, has more contraction in it than the clay around the hole.

G. CARTWRIGHT: If it is too soft it will shrink more than the body around it

T. A. SHEGOG: Exactly; that is what happened, so I added the flint to get rid of some of the contraction.

W. G. JACKSON: In dipping ware we have trouble sometimes in having dry spots on large pieces of hollow ware. The answer seems to be to reduce the amount of dope, but if we get it down too far it makes it hard to cast.

T. A. SHEGOG: Does it spot vertically?

W. G. JACKSON: We simply have a point on large pieces such as jugs, numbers 6 and 12, where there is a dry streak on it.

G. CARTWRIGHT: You can pour them with a funnel and it will stop it. Take a funnel and run a long neck down within that as far as the bottom of the jug and pour the slip down the funnel. The man runs the slip down the side of the mold and it will be dry every time.

F. H. RHEAD: We had the same trouble with some of our various porcelain products, and on investigating the matter we found that the slip would hit the side of the mold in one spot. We introduced the funnel and we had no more dry spots.

T. A. SHEGOG: That is the same case that was discussed a little while ago.

W. G. JACKSON: We had no discoloration so I thought it was not the same thing.

T. A. SHEGOG: It is only in the big ware that there is discoloration. You get the dry spot every time.

Question 27 By using scrap over again in the casting body, what effect should a person expect to encounter? Would it require more dope the second time that you flocculate this clay? Would there be a change that would be noticed in the strength of the body? (About 15% scrap.)

W. L. SAMPLE: We have found that we can introduce a large quantity of scrap (15 or 20%). We try not to let the scrap get dry before we put it in. There is not enough difference there to be noticeable.

H. GOODWIN: With us it is very different. We find it better to dry the scrap and use in our raw charge (not scrap mill) about $2^1/_2\%$ of the 1500-pound charge. We experienced considerable trouble with our clay on the jigger when returning all casting scrap through the scrap mill, due in a great measure to this scrap probably getting pumped into the presses when little raw stock was in the agitators. We decided to eliminate casters'

scrap for one week with good results, but if consistently mixed in raw mills its introduction into the body does not have any effect at all.

T. W. BLACK: We had a similar trouble. Dr. Mellor made a suggestion and I got rid of it entirely by using a little acetic acid in the blunger.

C. B. YOUMANS: That is why we use acetic acid. We weigh every bit of scrap that goes back into the blunging tubs and measure the acetic acid, so that we can dilute the scrap to the pH value of 6 every time.

W. K. MCAFEE: I take it that the discussion so far has centered around the comparatively dry scrap. Strictly speaking, the drain slip that is put back in the blunger is really scrap. It has to do with the change in amount of electrolyte present. If anybody would have asked me down in Atlantic City how much we could use I would have said 5%. I now say 25%. Our scrap piled up on us when we thought we could only use 5%. It is all gone now.

If you determine the amount of electrolyte used by the action or behavior of the finished slip, you automatically compensate for the varying amounts needed. This amount is, of course, a function of the electrolytes introduced in the scrap used.

Question 28 Why will two mixtures that have the same total shrinkage when formed by the dry process have entirely different shrinkages with the same amount of water added, when cast?

A. V. BLEININGER: In the dry process the total amount of water present is insufficient to permit of the free movement of the particles, and their dispersion from aggregates to individual particles is entirely out of the question. In the damp state required for dry pressing the clay particles remain as aggregates and are made to cohere superficially only by pressure. All kinds of granular material, of widely differing character can be compacted by pressure. The granular condition persists also during the firing process so that no decided variation between different clays should be expected, while the plastic condition develops the structural peculiarities of each material.

In casting we are dealing with the presence of a large amount of water which permits of the flotation of the particles. The aggregates therefore, having freedom of motion, may be dispersed by deflocculation. No two clays react alike as regards this dispersed state and no two of them produce the same structure which persists in drying and firing. They are bound to show differences in shrinkage. It is apparent, then, that while two clays may show the same total shrinkage when dry pressed, where they possess only a small water content and necessarily no freedom of motion, they are almost certain to differ decidedly when cast, and at liberty to develop all the possibilities of deflocculation and coagulation.

GETTING THE HIGHEST RETURN FROM KILN EQUIPMENT[1]

By John R. Green

ABSTRACT

Description of a recording pyrometer set up, the conditions to be observed and the benefits derived.

Introduction

The statement has been made that a large proportion of the labor saving and quality improving machinery and devices in the hands of operators today is not giving maximum return on the investment because of improper installation or insufficient attention in operation. The management is sold on the principle back of the installation but fails to pass on to the operating department the details in usage and upkeep. It is entirely possible that a part of this failure is the fault of the manufacturer to supply minute operating information and suggestions.

The purpose of this article is to review briefly the selection, installation and operation of the thermometer and pyrometer equipment with particular attention being paid to applying the instrument to everyday plant practice, and a consideration of the value of temperature-measuring equipment.

The first measurement of temperature effects in ceramic firing was the draw trial, next, the shrinkage bars, kiln settle, the Wedgwood gage, pyrometric cones and the Veritas firing rings. The pyrometric cones invented by Seger are the most important of the visual means of determining heat treatment in ceramic kilns. This system is popular because it measures more closely than anything yet devised the actual heat treatment of the clay. Pyrometers give information needed concerning the temperature conditions while the kiln is still black although under fire, and while the carbon is being burned out. We have come to the realization that some of the causes of losses in the finished clay products are due to mistreatment during these early stages of the firing, where actual temperature measurement and the rate of temperature increase are the only guides to good firing. For this work the indicating and recording pyrometer are the only satisfactory means of control.

The visual trial piece methods are continued in use because each gives information not possible to be obtained from others. The value of clay products, the cost of firing and the possible economies in firing are such that the management can well afford to use any or all of the systems known if by their use the firemen have more intelligent control. In the *Transactions of the American Ceramic Society* are lengthy discussions as to the respective merits of cones and pyrometer systems, all of which ended with the agreement that the work done by both were complements

[1] Recd. Apr. 14, 1925.

of each other and that the use of all means available to control kiln firing were none too plentiful.

Consideration of pyrometers naturally come under three headings: (1) the equipment, (2) installation, (3) use.

The Equipment

Every pyrometer installation is composed of three units: (1) the thermocouple located at the point where temperature measurement is desired, (2) lead wires extending from the thermocouple to the instrument, (3) the indicating and recording instruments with suitable switching mechanism.

The thermocouples are (1) rare metal couples, giving long life and constant readings of temperatures to 3000°F, (2) base metal thermocouples at approximately one-fourth the original cost, of shorter life than rare metal when used at the same temperature but can be used in ceramic work for temporary temperatures as high as 1950° or 2000° depending upon atmospheric conditions in the kiln, *i. e.*, oxidizing or reducing.

A protecting tube is used to exclude gases from contact with the wires. Porcelain tubes of different compositions are used depending upon the temperature to be withstood. An outer protection of fire brick is a mechanical protection for the porcelain tube. The thickness of the crown or side wall will determine the length of thermocouple to be used. A 9-inch crown requires an 18-inch thermocouple and a 13-inch crown a 24-inch length.

All thermocouples for outside use should be made entirely weatherproof. Rain or snow in the porcelain tube or on the exposed terminals will make the readings inaccurate. A covering over the fire brick tube can at the same time hold the inner tube in exact position and not allow any moisture into the tube.

The wiring for all outside ceramic plant work will consist, in practically all cases, of No. 14 wire. This should be supplied with weatherproof insulation for open runs, and asbestos insulation wherever the wires pass over hot crowns, open crown holes or near fire boxes. There are two systems commonly used in wiring: (1) the individual return, in which two separate wires connect each thermocouple with the instrument, (2) the common return system in which one wire is made to answer for the negative return from all thermocouples, with individual wires from the positive side of each thermocouple to the instrument. The individual return is recommended unless the length of leads demands common return for economy.

The indicating and recording instruments must be simple in operation. Kiln firemen are not laboratory scientists, and an instrument must be placed in their hands that is simple and easy to operate or their support

is lost. The instruments must be rugged in construction to withstand the severe conditions found in the average plant. All instruments should be encased in dustproof cases. The indicating instrument should have numbers that are easily read. A recorder of the continuous strip chart variety is the best because it is easy to read, and continuous in operation. It should be possible to mark directly on the chart at the time the record is being made, such notations as, water-out, carbon-out, settle readings, damper settings, or any other information which is d rectly related to the operation of the firing.

Installation

Thermocouples Where temperature is to be measured at one point only the thermocouples should be located in the crown as near to the center as possible. Three-quarters way up the crown usually is good practice.

The depth of insertion of the fire brick tube into the kiln depends on circumstance; 3 to 6 inches is common practice. In some cases the tubes are mounted flush or even recessed into the crown in order to use base metal for high temperatures. The farther the thermocouple extends into the kiln the more nearly will it record the temperature of the entire kiln.

The thermocouples in all kilns should be inserted to the same depth to obtain comparable readings. Quite frequently a kiln foreman will complain that one kiln requires an entirely different temperature schedule from another, and while this may be due to difference in design, draft conditions, etc., yet on inspection it is usually found that the thermocouples have been installed in widely different ways.

The heavy fire clay tube causes a time lag in the readings. Where greater sensitivity is required, as in some tunnel or chamber kilns, the ends of the fire clay tubes may be ground thin. This allows sensitive readings and yet does not expose the porcelain tube to the direct flames. The actual installation of the fire clay tube is a simple matter. A 3-inch hole is knocked out of the crown, the tube laid in with fire clay or clay mortar, and also supported by a curved flange that fastens onto the tube and rests on the crown.

In most heavy clay products work the actual measurement is the difference in temperature between the hot end of the thermocouple in the kiln, and the so-called cold junction at the head of the couple. The temperature at the indicating and recording instruments is assumed to be constantly near 70°F. The temperature where the thermocouples join the lead wires should be kept at 70°F. The weatherproof cover helps to maintain this constant temperature, although additional protection is desirable.

Where two thermocouples are used the second is installed through the base of the kiln, or into the flue leading to the stack.

The Instruments The instruments should be placed on a level with the eyes with good light and in a room used by the firemen as a resting place.

Use of Pyrometers

Any manager who expects to decrease his coal consumption and increase the quality of his ware simply because he has a pyrometer in the fireman's shanty is fooling himself badly. A pyrometer will never take the place of a good man on the business end of a No. 10 scoop. The fireman should not be a slave to the pyrometer.

In addition to temperature and time the fireman must consider draft in the stack and balance of pressure in the kilns both of which affect heat distribution. The fireman must consider the character of the kiln atmosphere, *i. e.*, oxidation or reduction. It is good policy to urge firemen to pay attention to kiln conditions rather than emphasize pyrometer readings. He will pay enough attention to the temperature because it is easy to do and he needs urging to watch the kiln itself in order that the correct proportion of attention may be given to each factor governing the firing.

Consider a pyrometer in the same class of equipment as the steam gage or speedometer. Analyzing the data from the boiler gage and the speedometer is simple because the results are immediately visible, while in the case of a kiln operation the results are not seen for several days. Some form of record must be maintained to check with the results observed when later the kiln is drawn.

Recording instruments give (1) a record of temperature development throughout the firing, (2) an incentive for the burner to make a perfect record.

At a glance it is possible to learn (1) the rate of temperature increase, (2) regularity in firing, (3) length of firing.

Evenness in firing is considered important. In the recent investigations by the Bureau of Mines fuel saving was obtained most often by regularity and frequency in firing. Quoting the report: "By firing little and often the temperature fluctuation is not so great and the temperature rise is more gradual. Whenever there is a drop in temperature it represents a time loss and fuel loss equal to the time and fuel necessary to regain lost temperature."

Water-smoking The water-smoking period of the kiln is one in which damage may be done and in which time and fuel may be saved. Speed and safety in the water-smoking period are dependent on draft and temperature.

During the water-smoking period the fireman should hold the top and obtain between 200 and 250°F in the bottom.[1]

A cold poker placed temporarily in the bottom of the kiln, and withdrawn to observe condensed moisture is probably the most common method of judging when the moisture has been driven from the kiln.

From this point on, the temperature of the kiln may be raised practically as rapidly as possible to the oxidizing period. The Bureau of Mines finds that "during the kiln investigation most of the time saving has been made during water-smoking. This has been done by improving the draft, by pushing the water-smoking along faster and by boosting the temperature to the oxidation period just as soon as the danger of water-smoking is over. Apparently it is the general practice among kiln firemen to hold back the temperature unnecessarily for a long time after the danger of water-smoking is over. When the bottom course of brick in a down-draft kiln has attained a temperature of 300° to 400°F (depending upon the nature of the clay) the temperature of the kiln can be boosted rapidly and safely to the oxidation period. If any damage has been done during water-smoking it has occurred under 300° to 400°F.

Oxidation Oxidation starts in the neighborhood of 900°F but progresses most rapidly between 1200° and 1400° depending upon the clay. Trial pieces drawn hourly will show the temperatures for each particular clay at which oxidation is most rapid, and also the length of time required for safe firing.

Soaking After the possibility of black core has disappeared, the firing may be pushed to the temperature of finishing or soaking. This temperature is usually far enough below the danger point of fusion to allow a good margin of safety. The kiln is held at this temperature until the desired amount of heat treatment has been given. This end point may be indicated in a variety of ways. With clays which have a wide vitrification range the completion of a predetermined firing schedule will be sufficient to assure a good firing. In firing clays which are more difficult to handle it is usual to test some property of the clay itself such as (1) color, (2) shrinkage, or (3) "ring."

In salt-glazing, pyrometers will indicate when the temperatures between saltings have recovered. This results in a saving in time, fuel and salt. Pyrometers make possible a similar positive control in flashing.

[1] A recording thermometer may be used to take the bottom temperatures. A 2-inch iron pipe with a cap over the end is placed into the flue leading to the stack and just outside of the kiln extending into the flue for a distance of 12 to 18 inches. A recording thermometer of the gas-filled type is hung on the kiln bands above this pipe, the bulb being dropped into the end of the iron pipe. The thermometer should have a range of 0–600 or 800°F.

Cooling To obtain maximum kiln turnover they should be cooled as rapidly as the ware will allow. This is a matter of rate of temperature decrease. Opening crown holes and wickets should be scheduled by the temperature change rather than by time. A recording pyrometer will show the actual rate of cooling. Where fans are used to hasten the cooling the pyrometer must be watched even more carefully.

Results Possible with Pyrometers

Savings in Fuel

1. More efficient firing by maintaining even temperatures.
2. More effective firing by holding at the temperatures where the results desired will progress most rapidly.
3. Cutting total radiation losses by shortening the firing time.

Savings in Time and Increased Turnover

1. More effective and efficient firing shortens the firing time.
2. Rapid raising of temperature from the water-smoking period to the oxidation, etc.
3. Reduction of cooling time by the control of the cooling rate.
4. Records of idle periods will display opportunities for quicker turnover.

Decreased Depreciation of Kiln

1. Uniform rates of heating and cooling minimize expansion and contraction strains.
2. Indication of dangerous temperatures saves firebox and kiln linings.

Increased Quality of Ware

1. Eliminate "slabbed" ware by observing correct water-smoking temperatures.
2. Do away with "black core" and "swells" by using correct oxidizing temperatures.
3. Safeguard against overfired material by keeping away from the fusing temperature.
4. Eliminate checked or "dead" ware by the control of the cooling rate.
5. Produce uniform products from top to bottom, requiring less sorting.

Fuel, time, depreciation and quality may be figured in the common denominator—dollars and cents.

Brown Instrument Co.,
Philadelphia, Pa.

THE FAILURE OF THERMOCOUPLE PROTECTION TUBES IN GLASS MELTING FURNACES[1]

By Herbert Insley

ABSTRACT

The unusually rapid failure of thermocouple protection tubes when used in glass furnace atmospheres has been found to be due to reaction of the volatilized alkalis in the atmosphere with the aluminum silicates of the tube. Failure of the tubes is due either to differential thermal contraction between the outer reaction layer and the inner unaltered layer of the tube on cooling or to actual corrosion and dripping away of the tube. It is suggested that the use of a much higher percentage of alumina and lower percentage of silica in the tubes may prevent failures from this cause.

It is well known that porcelain thermocouple protection tubes deteriorate rapidly in a glass furnace atmosphere if they are not shielded by additional refractory coverings. The usual method of protection is to fit the tube into a hollowed-out silica brick which projects into the tank and although there are obvious disadvantages in such an installation, they are more than counterbalanced by the longer life of the protected tube.

Previous investigations[2] have shown that corrosion of glass tank refractories may be caused by the action of the furnace atmosphere and it was thought that the failure of the thermocouple tubes might be due to the same cause. Microscopic examinations of thermocouple protection tubes were made in order to see what structures, comparable to those developed in refractories under the same conditions, were present. Samples of unused tubes and tubes used in other types of ceramic kilns were also examined. Many of the tubes examined were made at the Bureau of Standards of a batch developed there, the composition as calculated from the batch weights being: SiO_2 34%, Al_2O_3 64%, K_2O 2%. The glaze applied to the tubes had approximately the following composition after calcination: SiO_2 75%, Al_2O_3 15%, CaO 5%, MgO 1%, K_2O 4%. The tubes were fired to cone 18, a temperature of 1480°C having been reached after approximately 48 hours' firing.

There were available for microscopic examination: (1) unused tubes, (2) tubes which had been used at 1450°C for 72 hours in a kiln for testing refractories, and (3) tubes used for about a week in a pot furnace whose temperature was, in general, 1425°C and in which optical glass was being melted.

(1) The unused tubes were found to be composed of mullite ($3Al_2O_3 \cdot 2SiO_2$) crystals, glass, and dehydrated, partly transformed clay matter. There was only a small amount of glass present, which may account for the fact that the mullite crystals were short, stubby prisms and not the long, slender needles usually found in porcelain bodies. The glaze had

[1] Published by permission of the Director, Bureau of Standards.

[2] Insley, *Jour. Amer. Ceram. Soc.*, **7**, 583–93 (1924).

penetrated the body to a slight extent, as indicated microscopically by an increased percentage of glass near the surface. Mullite crystals at the junction of body and glaze were small and scattered.

(2) The cross section of the hot end of the tube exposed to 1450° C for 72 hours showed three very distinct zones: (*a*) an outer zone of glass about 0.25 mm. thick which undoubtedly represented the glaze; (*b*) a middle, porcelain-like zone which was quite vitreous and extended about half-way through the tube; and (*c*) an inner, less vitreous zone. The microscopic examination showed the outer zone *a* to be composed entirely of glass with an index of refraction of about 1.515. At the junction of the glaze and zone *b*, long, well-formed needles of mullite projected into the glaze. The middle, vitreous zone *b* was composed of stubby prisms of mullite and a fair quantity (perhaps 50%) of interstitial glass. No other constituents were observed. The inner, less vitreous zone *c* contained stubby prisms of mullite, much smaller than those in the middle zone, and a much smaller percentage of interstitial glass than the middle zone. The vitrification in the middle zone was evidently due to the absorption of part of the glaze by the body.

(3) The tubes from the glass furnace were not used longer than one melting period of seven or eight days and the furnace was maintained at a temperature of about 1425° C during most of the time. All the tubes showed the same characteristics and all failed in the same way. It is noteworthy that they apparently remained intact until the final cooling took place when a part of the hot end broke off. At or near the hot end of the tube the cross section showed two distinct zones; an outer very vitreous zone and an inner less vitreous zone. In some cases the hot end was entirely composed of the more vitreous material. Toward the cooler end of the tube the more vitreous outer zone gradually decreased in thickness until it disappeared. A microscopic examination of a thin section showed very striking differences in the structure and composition of the two zones. (Fig. 1.) The inner less vitreous zone was composed of mullite and glass with perhaps a slightly larger percentage of glass and a somewhat better development of the mullite crystals than the unused tube. The outer vitreous zone contained small but well-formed plates of corundum (Al_2O_3) embedded in glass whose index of refraction was about 1.525. The amount of corundum was apparently about the same as that of glass. In many of the pieces of tube the outer and inner zones could be easily broken apart because of the formation of a crack at the junction.

A commercial protection tube which had been used in the Bureau glass melting furnace for one melting period (about a week) was also examined. In this tube three zones were observed which represent the portions exposed to different conditions: *a*, a non-vitreous portion at the cold end of the tube still covered with the original glaze, representing the unaltered tube;

b, a slightly more vitreous zone nearer the hot end of the tube, and *c*, a vitreous outer zone surrounding zone *b*. About one inch of the extreme end of the tube within the furnace was broken off, the broken edge showing only zones *b* and *c;* zone *a* made up the cold end and became thinner toward the hot end until it disappeared. It was composed of small, rounded, more or less prismatic crystals embedded in glass, the crystals resembling mullite in their optical properties. Long needles of mullite extended from the body into the glaze. Zone *b* was composed of glass with an index of refraction between 1.52 and 1.53 and small, well-formed plates of corundum less than 0.05 mm. in greatest dimension. Zone *c* was composed of glass and an artificial soda-lime feldspar with the optical properties of labradorite. Quantitative measurements indicated that this feldspar was composed of about 30% of the soda feldspar ($NaAlSi_3O_8$) and 70% of the lime feldspar ($CaAl_2Si_2O_8$).

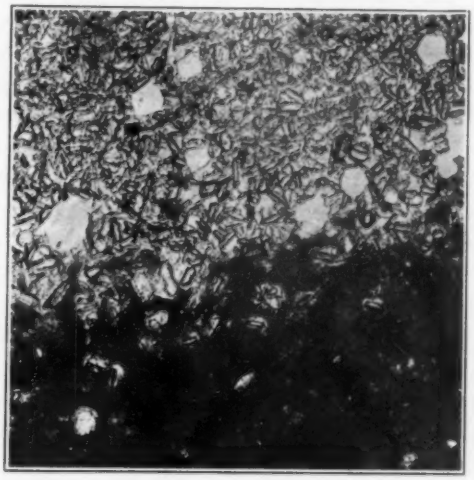

FIG. 1.—Photomicrograph of Bureau of Standards thermocouple tube used in a pot furnace melting optical glass. The contact between the lighter vitreous zone composed of corundum and glass and the darker, less vitreous zone composed of mullite and glass, is shown; magnification, 100 ×.

Experimental tubes containing silica and alumina in such proportions that after firing they would have a composition like that of sillimanite ($Al_2O_3.SiO_2$) were made by a porcelain manufacturer. One of these tubes was used in a Bureau of Standards pot furnace and another in a commercial pot furnace. The former lasted for seven or eight days, but was found to be cracked when the furnace had cooled down. The end of the tube which had not been exposed to the heat was composed of well developed mullite crystals, much larger even than those found in well fired clay bodies. The crystals were embedded in a relatively small amount of glass. The end of the tube exposed to the heat was covered with a brown vitreous skin of glass full of hexagonal plates of corundum. This layer covered an inner zone which was essentially like the cold end of the tube in its constituents but which was more vitreous in appearance and contained more glass and less mullite. The end of the tube within the furnace was much more brittle than the end outside of the furnace.

The tube of the same type which had been placed in a commercial pot

furnace had probably been exposed to more severe heat treatment and more corrosive action. The end was entirely gone, having fluxed or broken away. A microscopic examination of the tube at the break showed that this portion was entirely composed of corundum and glass. The corundum was arranged in overlapping parallel plates which were approximately perpendicular to the outer surface of the tube.

Causes of Failure

A comparison of the results of the microscopic examination made on tubes exposed to glass furnace atmospheres and on tubes exposed to kiln atmospheres at temperatures approximately equivalent shows that many of the constituents are different in the two cases. The tube used in the kiln for testing refractories still retained its original glaze and contained no corundum. The tube used in the glass melting furnace was covered with a crust of corundum, it contained a relatively large amount of glass, and it was thoroughly vitrified in the portion exposed to the heat and atmosphere of the furnace.

Since all of the thermocouple protection tubes used in glass melting furnaces had been exposed to the atmosphere of the furnace only and had not been in contact with the molten glass itself, they were subjected to practically the same conditions as refractories above the glass line in melting furnaces. A comparison of clay refractories and the thermocouple tubes exposed to glass furnace atmospheres shows a great similarity in structure and in the reaction products. In both materials the action of the soda or sodium compounds in the gases and dusts on the aluminum silicates causes the formation of a glass (a liquid at furnace temperatures) which Wilson[1] on the basis of chemical analysis, decided had a composition of approximately $Na_2O.Al_2O_3.5SiO_2$. Any alumina in excess of this composition forms crystals of corundum which are present as crusts on the surface of the material. The one tube mentioned above, in which there was an outer layer of soda-lime feldspar superimposed on the layer of corundum and glass, was probably exposed to batch dusts containing so much lime that the feldspar formed had a melting point above the temperature of the furnace and was easily crystallizable.[2]

In commercial pot or tank furnaces where a high temperature is maintained continuously and where the furnace atmosphere is constantly full of batch dusts and volatilized materials, the thermocouple tubes are actually corroded by the reaction between the aluminum silicates of the tube and the substances in the atmosphere. If the percentage of silica

[1] *Jour. Soc. Glass Tech.*, **2**, 197–213 (1918).

[2] The melting point of a feldspar of this composition (soda feldspar 30%, lime feldspar 70%) when pure is about 1495° C. Bowen, *Amer. Jour. Sci.*, **35** [4], 583 (1913).

is high, a large quantity of liquid is formed on the tube. This liquid drips away, carrying corundum crystals with it until the tube is eaten through.

In experimental furnaces like those used at the Bureau of Standards, the melting period is comparatively short. Only the outer portion of the tube is affected and the liquid formed usually does not drip away. After use, such tubes have an outer glassy layer in that part exposed to the high temperatures and the furnace atmosphere. There is often a cleavage plane between the outer and inner layer so that the outer layer falls off or may be picked off easily with the fingers. Cracks extend through the tube and often the entire end of the tube breaks off. The fact that tubes in use in experimental furnaces fail during the cooling period suggests at once that the splitting away of the outer layer of the tube may be due to differences in thermal expansion between it and the inner layer. G. E. Merritt, of the Bureau of Standards, made thermal expansion measurements on pieces of the outer and the inner zones of the used thermocouple tubes the results of which are shown in Fig. 2. From these curves it is seen that during the cooling of the furnace, the outer zone tends to shrink more than the inner zone. There is a weakening at the junction and the outer zone cracks lengthwise in order to relieve the tensile stresses.

Suggested Improvements in Thermocouple Protection Tubes

The microscopic evidence shows clearly that the action of the dusts and gases in the furnace atmosphere on the thermocouple tubes causes the formation of a glass and corundum (Al_2O_3). The formation of the glass, which is a mobile liquid at these furnace temperatures, is apparently the cause of the failure of the tubes.

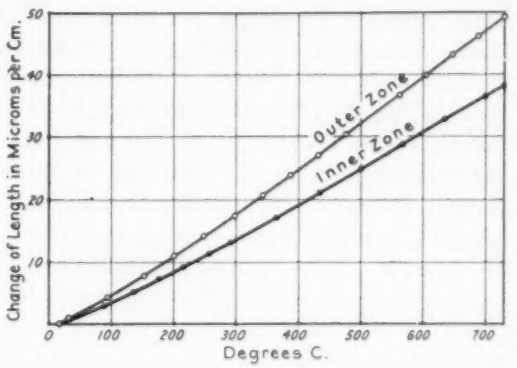

FIG. 2.

A possible method for preventing the formation of a large amount of silicate liquid suggests itself; that is, by increasing the ratio of alumina to silica in the body so that only enough silicate liquid is formed after the reaction with the soda in the furnace atmosphere to form a matrix in which the excess alumina may crystallize.

With this in view, a batch was made up of calcined alumina, ball clay and feldspar in such proportions that the body would have a composition of approximately 14% SiO_2, 85% Al_2O_3 and 1% of alkali. The body

cast satisfactorily, but was somewhat weak in the dried state and showed excessive shrinkage when fired. A tube of this composition was placed beside a tube of the usual type in the pot furnace at the Bureau. At the end of the melting period the experimental tube was somewhat deformed but still intact, while the other had cracked badly and pieces of the outer layer had spalled off. There were no traces of spalling and no cracks in the high alumina tube, but the surface was crusted over with minute corundum plates. Through the kindness of A. R. Payne, of the Hazel-Atlas Glass Co., another tube of the same type was placed in a tank melting bottle-glass. The tube was mounted without protection in the end of the tank about midway between the two filling-in dog houses, 18 inches above the glass line, and projecting 6 inches into the tank. It lasted about five days after the temperature had reached about 1430°C and two days after the filling with batch had begun. According to Mr. Payne's statement, this is about the average length of life of the ordinary unprotected pyrometer tube. It was thought, from the appearance of the tube used in the Bureau furnace, that failure might have been caused in part by mechanical weakness. It is now planned to make up a batch eliminating the feldspar and substituting "fused" alumina for calcined alumina.

Summary

Thermocouple protection tubes used in glass furnaces fail much more rapidly than the same tubes used in the ordinary ceramic kilns even though temperatures may be practically the same. Microscopic examination and other evidence shows that the volatilized alkalis and the alkaline dusts in the glass furnace atmosphere react with the aluminum silicates of the thermocouple tube, causing the formation of a liquid with a composition approaching the formula $Na_2O.Al_2O_3.5SiO_2$. In this liquid excess alumina crystallizes as corundum. Failure may take place in two ways: (1) If the reaction between the alkalis in the furnace atmosphere and the aluminum silicates of the tube takes place intermittently for short periods of time, the reaction liquid may occupy only the outer layer on the hot end of the tube. The solidified liquid has a different thermal expansion than the interior of the tube and cracking and breaking take place during cooling. (2) If the reaction takes place uninterruptedly at high temperatures, the liquid formed drips away and the tube is actually corroded.

The use of much higher percentages of alumina in the tubes than have heretofore been used is suggested in order that after reaction with the alkalis there may be a large amount of crystalline corundum on the surface of the tube and a small amount of liquid silicate.

CERAMIC ABSTRACTS

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Abrasives

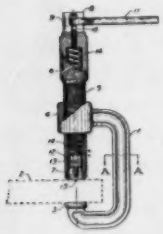
Bauxite. British Guiana. ANON. *Indus. Australian & Min. Stand.*, **73**, 686(1925). —Bauxite mining in British Guiana has developed into an industry of national importance. Shipments during 1923 amounted to 100,346 tons of ore with a declared value of $5.30 per ton. O. P. R. O.

Marundites and allied corundum-bearing rocks. Transvaal. ANON. South Africa Geol. Society, *Trans.*, **25**, 43(1924).—Marundite occurs extensively in Northern and Eastern Transvaal, and Natal. Mineralogically it is characterized by margarite and corundum (hence its name) as essential minerals present in the proportions varying roughly from 9.1 to 1.1, with as much as 50% of corundum. Chemically it is characterized by a very high content of alumina (up to 70%) and a relatively low amount of silica. O. P. R. O.

PATENTS

Preparation of bauxite. A. MCD. MCAFEE. U. S. 1,543,934, June 30, 1925. In the prepn. of bauxite for the manuf. of aluminum chloride therefrom the process which comprises dehydrating the bauxite at a temp. below that at which substantial shrinkage takes place and then catalytically depositing carbon in its pores.

Means for determining the relative hardness of abrasive or similar substances. F. A. MANCE. U. S. 1,544,332, June 30, 1925. A device for testing the degree of resist. offered by a substance to the opern. of a cutting tool, which consists in the combination of a seat for the substance and a tool having a cutting surface; means for driving said tool into contact with said substance when supported on said seat with a predetermined degree and quality of driving force; means for gaging the extent of the penetration of the tool into the substance; means to maintain on said tool, after said initial operation, a constant and uniform press.; means to cause said tool under such press. to operate on said substance with a cutting action; and means for gaging the extent of the penetration of the tool under predetermined conditions and time of opern.



Abrasive composition. HENRY R. POWER. U. S. 1,544,343, June 30, 1925. An abrasive compn. comprising abrasive particles and an algae jelly-product, said compn. being substantially free from either alum or oil substantially as described.

Vitreous bonded silicon-carbide abrasive article. MILTON F. BEECHER, A. A. KLEIN and W. W. GREENWOOD. U. S. 1,546,115, July 14, 1925. The method of forming a vitrified abrasive article comprising the steps of mixing silicon carbide grains with a protective, vitrifiable plastic ceramic bond of low reactivity which is capable of being completely fused to a glassy condition at Seger cone 10, shaping the mass and firing it under a heat treatment which fuses the bond without causing material dissociation of the silicon carbide and coats the grains uniformly, thereby uniting them into a unitary structure.

Art

Design. ANON. *The Pottery Gazette and Glass Trade Review*, **50** [575], 767–70 (1925).—This is a report of a lecture given by Paul Nash, Instructor of Design at the Royal College of Art, at a meeting of the Art Section of the Ceramic Society. "To design" was defined as being "to determine," and "design" was defined as being "the expression of purpose animated by spiritual force." A distinction was made between "pattern" and "design" which are too often considered identical. "Rhythm" was defined as the animating force of all expression or as a spiritual agent, animating the material elements of the universe. It was shown how the sense of rhythm comes to people who work by their intuition rather than by their intellect. "Aesthetics" was defined as a sense of beauty in objects. To create something for others which they could not create themselves was given as the function of the artist. The essential qualities of any painting, were given as those which went to make up unity, namely: form, order, variety, a sense of space, an idea of movement, an idea of mass, color and a sense of light and shade. P. D. H.

Notes on Whieldon pottery. W. EMERY. *The Pottery Gazette and Glass Trade Review*, **50** [575], 770–72(1925).—This is a report of a paper read by E. at a meeting of the Parent Section of the Ceramic Society. Some hundreds of pieces of Whieldon pottery have been unearthed and collated recently and the notes are based on these findings. The types of ware found were slip decorated, salt-glazed, black and red-glazed, agate and mottled. P. D. H.

Cement, Lime and Plaster

Action of sodium and magnesium sulphates on constituents of Portland cement. G. R. SHELTON. *Ind. and Eng. Chem.*, **17** [6], 589(1925).—Deals with the problem of the action of the so-called "alkali" waters on concrete structures. Describes the prepn. in the pure state of the major substances present in Port. cement clinker, tricalcium aluminate, β-dicalcium silicate and tricalcium silicate and the effects produced on these constituents by solns. of sodium and magnesium sulphates of various concns. F. G. J.

The setting of cement. H. MALGRAIN. *Rev. Mat. Constr. Trav. Pub.* **186,** 57–60; **187,** 91–3(1925).—I. Gen. considerations. The setting of cement is considered as being due to the hydration of each of its constituents, and may be expressed as the summation of a number of first order reactions, namely $dx_1/dt = k_1(A_1 - x_1)$, where A_1 is the original quantity of a constituent, x_1 the quantity hydrated at the instant of time t_1, the differential expression being the speed of reaction, and k_1 a constant. II. Variation of duration of set as a function of temp. Duration of set is taken to mean the length of time between initial mixing and the moment when a Vicat needle 1 mm. square weighted by 300 gs. does not penetrate the mass. A pure cement was allowed to set in contact with water-satd. air in a const. temp. app. The chem. anal. of the cement was SiO_2, 18.6%; R_2O_3, 18.6; CaO, 58.2; MgO, 4.32; K_2O, 0.3; SO_3, 0.3; the free lime content being 5%. The results were 6.5°C, 38 hr.; 10°, 15 hr.; 15°, 8.25 hr.; 22°, 7 hr.; 28°, 5.42 hr.; 40°, 3.25 hr.; 50°, 2.58 hr.; 60°, 1.83 hr.; 70°, 1.17 hr.; 80°, 45 min.; 90°, 30 min. The setting of the cement may be expressed as the logarithmic function of the temp., and may be represented by an hyperbola. III. The processes involved in setting. Stage (1). From the time of final mixing the cement hydrates rapidly and gains strength equally fast, the usual period being a few hrs. Stage (2). Takes several weeks to be completed, and during the time the strength increases less rapidly than in stage (1). The predominant phenomenon is that of dehydration, but the hydration is actually completed and carbonation begun in the same period. Stage (3). This lasts several months. Dehydration is completed and carbonation is the

chief phase. The rate of increase of strength is much slower than in the previous stages. IV. Variation of resist. of cement with time. Briquettes made from the same large batch of cement were broken each day for the first 90 days, then on succeeding months for a year—three briquettes being taken for each day's test. The data given show that max. strength is attained in three months, after which the strength falls slightly with time. This is contrary to the belief that the strength increases proportionately to the logarithm of the time. V. Lime liberated during set. By treating the cement mixt. with a 10% sugar soln. the free lime is obtained in the filtrate where it may be titrated with sulphuric acid. A cement contg. originally 5% of free lime was found to have 7.8% at the completion of set, indicating a liberation of 2.8% of lime during set, attributed to the hydration, $SiO_2.3CaO + Aq. = SiO_2.CaO.2.5H_2O + 2Ca(OH)_2 + Aq.$ A quick setting cement contg. before mixing 4.53% free lime showed a content of only 2% of free lime after the final set, indicating a recombination of the free lime. The author criticizes the statement of Le Chatelier that the complete hydration of the tricalcium silicate (as indicated above) is the principal reaction of the setting of cement. He concludes that (*a*) a small amount of lime is set free during set, (*b*) this quantity is much smaller than would result from the total decompn. of the tricalcium silicate, (*c*) the quick setting cements which are fired at low temps. and are more rich in acid elements than the ordinary Port. cements contain very little tricalcium silicate. The principal hydraulic component is the tricalcium aluminate (and other aluminates) whose set is much more rapid than that of the silicate. VI. Combined water. Of 28% water used in mixing a cement which had an initial ignition loss of 6.9%, 7.9% of water actually combines with the cement. VII. Dehydration. After the final set about 20% of water is eliminated by evapn. VIII. Carbonation. The last phase of set is the carbonation of the free bases as lime and magnesia. L. N.

Plaster forms. M. DÜRRE. *Tonind. Zeit.*, **49**, 590(1925).—Good plaster should commence to set in 10–12 mins. and then gradually increase in hardness. The plaster should show only a noticeable warming due to setting. Extreme heating upon setting is usually followed by a poor strength and indicates that the plaster is inferior A good plaster should not settle to the bottom rapidly when thrown in water and should also not float on the surface. H. G. S.

Bauxite and cement industry in France. ANON. *Jour. Soc. Chem. Ind.*, **44**, 609 (1925).—Considerable developments are expected shortly in the bauxite industry, owing to the growth of the aluminous cement industry and the increasing use of Al metal and wire in electrical industries. French deposits of bauxite, approx. 55–60% Al_2O_3, are estimated at 60 million T. It is proposed to use bauxite also as a decolorizer of oil products, and it is now being used for oil filters. *Ciment fondu* production is steadily increasing. The difference in compn. between Port. and *fondu* cements is given as follows: SiO_2, Port. 23, *Fondu* 10; Al_2O_3, P. 7, *F.* 42; CaO, P. 64, *F.* 42; Fe, P. 4, *F.* 6; other, P. 2, *F.* 0. *Ciment fondu* fuses at 1400°C, its production, being rather expensive, is most practicable where cheap hydroelectric power and supplies of bauxite are at hand. The chief plants are the Lafarge works at Moutiers in Savoy and Teil on the Rhone, and the Agout Co. at Luzière in the Tarn. H. H. S.

Colored concrete. ANON. *Chem. Trade Jour.*, **76**, 734(1925).—Tests carried out by the Brit. Port. Cement Assoc. indicate that a permanent green for purposes such as hard tennis courts has been produced. The pigment consists of barytes stained with an organic dyestuff. It is said to be extremely resistant to alkalis, and to cost about a quarter the price of chromium oxide. H. H. S.

Examinations on cements high in alumina. THV. LINDEMAN AND SVERRE HASSEL. *Tids. Kemi Bergvaesen*, **4**, 149–53, 193–5(1924).—Various mixts. of pure Al_2O_3, SiO_2 and $CaCO_3$ were fused in an elec. furnace and the cooled melt was ground to 15% residue

on the 4900-mesh sieve. Tests were made for time of set and tensile and compressive strengths of normal sand mortars at 1 and 7 days. The products tested contained 3–22% SiO_2, 37–63% Al_2O_3, 25–49% CaO. *Conclusions:* $3CaO.5Al_2O_3$ is always slow-setting. Pure or in mixts. low in SiO_2 it will give rapidly hardening cements. If the SiO_2 content is increased the cement will be too slowly hardening. $CaO.Al_2O_3$ is the most valuable constituent of the alcement. If the SiO_2 content is increased above 13–15% the formation of $2CaO.Al_2O_3.SiO_2$ will be more prominent and the hydraulic properties of the cement will disappear. With a low SiO_2 content and so much of CaO that the compds. $5CaO.3Al_2O_3$ and $3CaO.Al_2O_3$ are formed, the cement will be too quick-setting. With more SiO_2 the formation of $2CaO.SiO_2$ will make the cement more slow-setting, but the strengths of the cements with less CaO are not reached. Similar mixts. contg. up to 9% FeO gave high early strengths and acceptable setting times, except one contg. SiO_2 15.5%, Al_2O_3 40.0%, FeO 3.1%, CaO 42.0%, which gave low strengths. All others so tested were lower in SiO_2. Small amts. of MgO had no harmful effect on strength. (*C. A.*)

The fundamental cause of the disintegration of concrete. A. H. White. *Concrete*, **26,** 157–61(1925).—Disintegration of concrete is caused by vol. changes due to changes in moisture content of the concrete. Frost action and corrosion of reinforcing steel are secondary, and if the concrete is free from cracks, unimportant. The expansion of neat cement bars stored under water at the age of 24 hrs. was: 7 days, 0.030%; 28 days, 0.053%; 2 months, 0.080%; 6 months, 0.090%; 1 yr., 0.100%; 2 yrs., 0.0116%; 5 yrs., 0.144%; 10 yrs., 0.150%; 15 yrs., 0.162%; 20 yrs., 0.161%. The contraction of bars stored in lab. air 15 yrs. and air over $CaCl_2$ 5 yrs. was: 7 days, 0.085%; 21 days, 0.180%; 2 months, 0.225%; 6 months., 0.285%; 1 yr., 0.303%; 2 yrs., 0.354%; 5 yrs., 0.381%; 10 yrs., 0.410%; 15 yrs., 0.416%; 20 yrs., 0.427%. (*C. A.*)

PATENTS

Artificial marble and like substances. E. Douzal. Brit. Pat. 207,497. *Quarry & Surveyors' and Contractors' Jour.*, **30,** 87(1925). The present process consists in melting in their crystallization water and at a temp. below boiling point a double salt such as alum or a mixture of two isomorphous simple salts (potassium and aluminium sulphates) which combine to produce a double salt, or again a mixt. of double salts isomorphous with one another (common alum and chrome alum), and mixing hydrated sulphate of lime in powder form with the salts thus melted, the treatment being conducted without the addition of water. These salts contain a high proportion of water in crystallization. The substance produced is a crystalline substance which can be molded, and has the appearance of Carrara marble, green Brazilian onyx, yellow Algerian onyx, marble of the finest and most translucent quality, jade and the like. The several types of marble can be had by varying the proportions of the substances employed, and by adding suitable coloring matter. As water must not be added, it is necessary to select salts containing a high proportion of crystallization water. When it is desired to produce variously colored marbles, the sulphate of lime is mixed with double salts or with mixtures of salts, these salts also containing a high proportion of crystallization water and being isomorphous between them in the case where several salts are used at once. O. P. R. O.

Cement manufacture. A. Petelot. Brit. Pat. 210,760. *Quarry & Surveyors' and Contractors' Jour.*, **30,** 88(1925). This invention relates to a special cement which is intended more particularly for coating purposes. In order to obtain a cement having the appearance of stone, the following composition is preferably employed: Zinc sulphate, 805 kg.; barium chloride, 1.035 kg.; ammonium chloride, 267.65 kg.; zinc oxide, 1,406.25 kg.; silica, 1,753.75 kg.; limestone, 5000 kg. The following composition will be found very suitable for cements having a marble and pottery appearance: Zinc

sulphate, 805 kg.; barium chloride, 1.035 kg.; ammonium chloride, 267.65 kg.; zinc oxide, 2233 kg.; silica, 4000 kg. First, the zinc sulphate is dissolved in a suitable quantity of water (6480 l., for instance, in the case of the compositions given above), at a temperature of about 15°C. After the zinc sulphate is dissolved, the barium chloride is added. The mass is then poured into a mixing apparatus, the desired quantity of ammonium chloride is added, and the mass is left to stand for a few minutes. A certain portion—for example, 406.85 kg.—of the zinc oxide is then added, and mixing is proceeded with. The mass is then evaporated in a kiln at a suitable, relatively low, temperature, for instance, 150°C. After suitable evaporation, the mass is rammed so as to fill up the hollows or cracks produced by the evaporation, and the temperature is raised to about 340°C, at which it is maintained for about 5 min. The mass is then left slowly to cool with the exclusion of air. The material thus obtained is then mixed with the remainder of the zinc oxide—for example, 999.4 kg., and with the necessary quantity of silica. The mixture is then pulverized at about 150°C; then, if necessary, the desired quantity of limestone is added and the whole is thoroughly mixed. The product is then stored in closed containers, as it is preferable to store it thus for at least 10 days before being used. O. P. R. O.

Artificial stone and the production of articles therefrom. W. H. Clegg and G. Whittaker. Brit. Pat. 221,857. *Quarry & Surveyors' and Contractors' Jour.*, **30**, 88(1925). For the purposes of the invention use is made of finely divided sulphur and siliceous sand, the latter being cleaned from all impurities and free from chalk, lime or other compounds of calcium. As an alternative, finely powdered china clay or iron or steel slag may be employed. In certain cases, asbestos fiber in a finely divided condition may also be employed. Suitable proportions for general use are about equal quantities by weight of the sulphur and of the sand or other materials. The sand is thoroughly dried and mixed with the sulphur. The mixture is then heated in a suitable apparatus, preferably in a jacketed pan, the cavity of which contains a heavy oil with high flash-point, so that it will not readily ignite. The pan is heated by means, such as gas, which will enable the heat to be easily regulated. The use of an oil-jacket ensures an even temperature all round the mixture in the inner vessel, and minimizes loss of heat by radiation. A suitable cover is provided to the pan to prevent free access of air to the mixture when heated. The mixture is heated to a temperature of about 400°C and maintained at this heat for a period of several hours, during which the mixture is frequently stirred. Generally speaking, a minimum heating period of six hours is required to ensure complete absence of air bubbles, and consequent freedom from blowholes of articles made from the mixture. During the mixing of the materials, or during the heating of the mixtures, any desired coloring matters may be added. O. P. R. O.

BOOK

A hundred years of Portland cement. A. C. Davis. Pp. xxii + 282. London: Concrete Publications, Ltd., 1924. Price 21s; Leather, 25s. H. H. S.

Enamels

Melting furnaces for enamels. F. Bigot. *Rev. Mat. Constr. Trav. Pub.*, **188**, 115–9B(1925).—Descriptions with drawings of two furs. for melting enamels. They are of the stationary type, the enamel being melted on a hearth. L. N.

Glass

The modern production of sheet glass. W. E. S. Turner. *The Pottery Gazette and Glass Trade Review*, **50** [575], 785–9(1925).—This is a report of a lecture delivered by T. at the Royal Society of Arts. The various processes in use in England, on the

Continent, and in America were described. Among them were the Fourcault and Colburn processes and that developed by the Ford Motor Car Co. P. D. H.

Glass research at the National Physical Laboratory. ANON. *The Pottery Gazette and Glass Trade Review*, **50** [576], 930–2(1925).—This is a specially abstracted report of work done by the Glass Research Association during the year 1924. The departmental reports include the following particulars: (1) Physics dept.—thermometers; clinical thermometers; colored glasses for railway signals and aircraft lights; roofing glasses for aircraft sheds; selective absorption of optical glasses. (2) Electricity dept.—standards of colored glass for ships' lights; standard colored glasses for railway signals; approval tests for ships' navigation lights and lenses. (3) Illumination—transmission of window glass, (*a*) direct light, (*b*) diffused light. (4) Metallurgy Dept.—glass research. P. D. H.

The bond of metals with glass. ANON. *Sprechsaal*, **58**, 309–10(1925).—The bond of various metals with glass and porcelain are discussed. H. G. S.

Glass furnaces fired with powdered coal. H. BARTH. *Sprechsaal*, **58**, 311–2 (1925). H. G. S.

Application of science to the glass industry. H. GÖTZE. *Sprechsaal*, **58**, 312–3 (1925). H. G. S.

The effective wave-length of colored glass used in optical pyrometry. F. HENNING. *Sci. Abst.*, **28** [4], 284(1925); *Zeits f. Physik*, **30** [4–5], 285–96(1924).—From the Reichsanstalt. By deduction from theoretical considerations the effective wave-length of a colored glass is shown to be a function of the color temperature of the radiation transmitted through the glass. An expression is established for the effective wave-length and is obtained from a comparison of the brightness of two sources of radiation of different color temps. The results so obtained are compared with the values calculated by Forsyth and Hofmann for the effective wave-length of Schott red glass F.4512, and good agreement is established. The results are compared in tabular form. A. F. G.

Simulating natural light in metallography. H. S. GEORGE. *Sci. Abst.*, **28** [4], 285(1925); *Trans. Am. Inst. Mining Eng.*, **70**, 259–73(1924).—A method of illumination that enhances the value of the microscopic study of opaque materials, as in metallography, consists in the partial eclipse of the illuminating beam by the insertion in its path of opaque discs of various diameters so as to stop off to various extents the axial rays. Structures possessing a relief are given a natural appearance and erroneous interpretation is avoided. The system is referred to as "conical illumination." Illustrations are given of microphotographs of sections of an iron-chromium-carbon alloy showing the obliteration by axial illumination of a constituent shown plainly by conical illumination. In another example, etching figures in ferrite, hitherto considered to be pits, are revealed as pyramids, standing in bas-relief. A. F. G.

The protection of original glass designs by patent. W. FAWCETT. *Glass Ind.*, **6** [7], 142(1925).—Designs may be patented for $3^1/_2$, 7 or 14 years at proportionate prices. Necessary qualifications are described. F. G. J.

The thermal efficiency of glass melting. D. J. MCSWINEY. *Glass Ind.*, **6** [7], 139(1925).—A discussion of factors governing fuel composition. F. G. J.

Causes of crizzles and skin-wrinkles of pressed glass. E. ZSCHIMMER, K. HESSE AND K. MEURES. *Glass Ind.*, **6** [6], 120 and [7], 146(1925).—Translated from *Sprechsaal* **58**, 185–7. Considers the glass gob as a leather bag full of liquid. In pressing, the resin may be fractured and crizzles result if it is required to expand greatly or if the mold is too cold. The automatic machines are superior to hand work in preventing this. Wrinkles are due to the contraction of the inner glass on cooling, drawing the surface with it. Several expts. illustrated. F. G. J.

Colored glass in goblet making. C. DUVIVIER. *The Glass Worker*, **44** [39], 13 (1925). (Translated from *La Verre*, Sept., 1924.) Describes how each of the principal colors are produced. Gives the proportions of oxides to be added, the alterations that must be made in the basic mixture, the proper melting conditions and the right consistency. F. G. J.

The Volstead Act caused many idle bottle plants. ANON. *Nat. Glass Budget*, **41** [9], 3(1925).—The demand for bottled beer extended throughout the entire year. "Soft drinks" do not create nearly the same demand for bottles. A number of bottle factories have curtailed production or shut down and the loss is felt in allied businesses. F. G. J.

English Society of Glass Technology discusses constitution of glass. ANON. *Nat. Glass Budget*, **41** [9], 13(1925).—At the May meeting of the Society of Glass Technology of England the following papers were read at a symposium on the constitution of glass: The Nature and Constitution of Glass, by W. E. S. Turner. On Glass as Supercooled Liquids, by G. Tammann. On the Constitution and Density of Glass, by A. Q. Tool and E. E. Hill. The Ternary System Sodium Metasilicate-Calcium Metasilicate-Silica by G. W. Morey and N. L. Bowen. X-ray Diffraction Measurements on Some Soda-lime Silica Glasses (a preliminary note), by R. W. G. Wycoff and G. W. Morey. The Structure of Quartz, by William H. Bragg. The Viscosity of Glass by Vaughan H. Stott. Abstracts of these papers are given. F. G. J.

Viscosity measurements with glass. V. H. STOTT, E. IRVINE AND D. TURNER. *Proc. Roy. Soc.*, **108A,** 154–71(1925); *J. Soc. Chem. Ind.*, **44B,** 449(1925).—Viscosity-temp. curves for 13 glasses were detd. by observing the time taken for rotation through a given angle when circular rods are subjected to a given torque. At high temps. the viscosities were detd. by measuring the rate of fall of a partially counterpoised sphere of Pt-Ir alloy through the glass. The viscosities found ranged from 10^2 to 10^6 C. G. S. units. H. H. S.

The glass industry. ANON. *Jour. Soc. Chem. Ind.*, **44,** 650(1925).—The course of the glass industry is said to have been completely changed within the last ten years, mainly by Colburn's mech. methods of mfg. glass, the patents of which have been acquired by the Libbey-Owens Co. The first mach. was made in 1905, and the first factory was built at Charleston, Va., in 1916. Success in the U. S. led to developments in Canada, Japan and Europe, most of all in Belgium where post-war reconstruction coincided with the elimination of the glass-blower. The International Company (Libbey-Owens process) established a factory at Gompel, Belgium, where the capacity of half a million sq. meters of glass a month is to be doubled. Four other companies are exploiting the process at Moutier (Switz.), Turin (Italy), and at two factories in France, while in Spain production is to begin shortly. H. H. S.

Characters of glasses in terms of their electromotive properties. J. ZIMMERMANN AND J. SCHNEIDER. Meeting, Vienna Acad. Sci., March 19. *Nature*, **115,** 931(1925). H. H. S.

Exchange of ions in glasses. K. HOROVITZ AND J. ZIMMERMANN. Meeting, Vienna Acad. Sci., March 19. *Nature*, **115,** 931(1925). H. H. S.

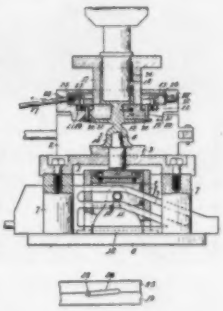
Germanium glasses. L. M. DENNIS AND A. W. LAUBENGAYER. *J. Am. Chem. Soc.*, **47,** 1945–7(1925).—The positions of Si and Ge in the periodic table make it evident that close analogies between their compds. are to be expected. Glasses similar to silicate glasses but in which SiO_2 is replaced by GeO_2, were therefore prepared, and it was found that four types of glass: flint, dense flint, borate crown and barium crown, were possible by replacing the SiO_2 by an equimolec. quantity of GeO_2. The GeO_2 glasses melt at considerably lower temps. than the corresponding SiO_2 glasses and are

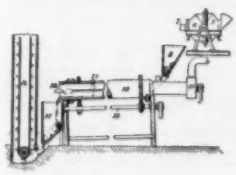
very transparent, free from bubbles, and quite stable, with a higher refractive index. It has also been found possible to make fused transparent GeO_2 similar in appearance to fused quartz. H. H. S.

Annealing glass with the electric leer. K. M. HENRY. *J. Electricity*, **54**, 356–8 (1925).—The nichrome heating units have a connected load of 160 kw. The power is supplied at 220 v., single-phase, 60 cycle. There is a continuously moving conveyor 5 ft. wide and 50 ft. long. The leer is divided into 3 parts: heating, annealing and cooling. Sil-O-Cel brick is used for insulating the leer. The heat control is maintained automatically within 3° by Leeds and Northrup controlling potentiometers. (*C. A.*)

PATENTS

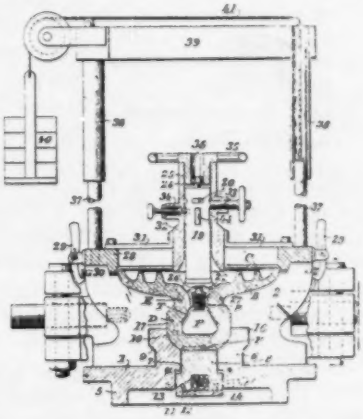
Glass-molding apparatus. C. B. ROE. U. S. 1,543,725, June 30, 1925. Glass molding mechanism comprising a sectional hinged mold, a base for said mold, a valve shiftable through said base into and out of coöperative ware-forming relation to said mold, means for elevating and lowering said valve, said mold having its top face provided with a seat, a mold member complemental to said hinged mold disposed on said seat, a ring mounted upon and vertically movable with respect to said complemental mold member, said ring carrying a plurality of depending pins which are vertically movable through said member, means for elevating and lowering said ring to effect elevation and depression of said pins, and a receiver for molten glass surmounting the central portion of said complemental mold member.

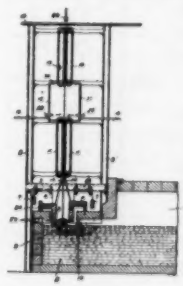




Glass batch. O. W. HILBERT. U. S. 1,543,770, June 30, 1925. The method of prepg. a glass batch from raw mats. that are in the form of a fine powder, which consists in thoroughly mixing the mats., and then subjecting the mixt. to heat of sufficient intensity to form the mats. into small granules, each of which is composed of the desired proportions of raw mats.

Manufacture of insulators. J. T. LITTLETON, JR. and GORDON S. FULCHER. U. S. 1,543,779, June 30, 1925. The process of mfg. insulators having a suspension pin molded therein, which comprises the steps of pressing a pin into the insulating mat. to embed it therein, and thereafter moving the pin with reference to the insulating mat. to space it therefrom without removing it from the insulating mat.

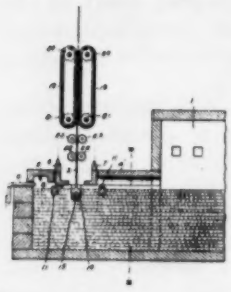




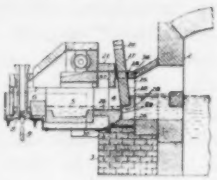
Apparatus for drawing glass. H. G. SLINGLUFF. U. S. 1,544,947, July 7, 1925. In combination in app. for drawing glass in sheet form continuously from a bath of molten glass, a pair of opposing belts or bands of flexible asbestos fabric, endless chains at the edges of the belts, and yielding supporting means between the belts and chains for pressing the belts against the glass sheet lying therebetween.

In combination in app. for drawing glass in sheet form continuously from a bath of molten glass, a pair of opposing belts or bands of flexible asbestos fabric, endless chains at the edges of the belts, bars extending transversely between the chains, and a series of spring pressed plungers on each bar engaging the rear faces of the belts.

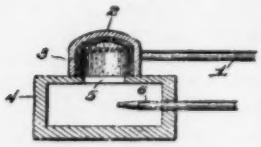
Apparatus for drawing sheet glass. H. G. SLINGLUFF. U. S. 1,544,948, July 7, 1925. In combination in app. for drawing sheet glass, a glass drawing tank adapted to carry a bath of molten glass from which a sheet is to be drawn, a clay bar extending transversely from one side of the tank to the other and entirely submerged beneath the glass of the tank and provided with a vertical slot lying longitudinally thereof and extending therethrough, and means for drawing a sheet upward from the glass above the bar and in alignment with said slot, the said slot having enlargements at its ends beneath the edges of the sheet being drawn.

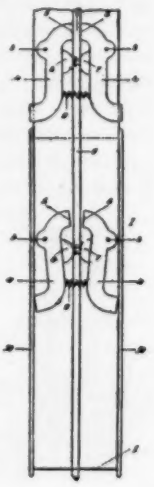


Cut-off block or valve for molten glass. GEORGE E. HOWARD. U. S. 1,544,987, July 7, 1925. A cut-off block or valve for molten glass comprising a stationary member of refrac. mat. having a flat surface, and a movable member of refrac. mat. disposed on the intake side of said stationary member and having a flat surface engaging the said flat surface of said stationary member, the said members having a substantial range of adjustment beyond their initial closing position, and being capable of wholly cutting off the flow of glass throughout said range of adjustment.



Method of drawing glass cylinders. WILLIAM WESTBURY. U. S. 1,545,222, July 7, 1925. The herein-described method of drawing glass cylinders, which consists in providing a ladle having a glass receiving chamber internally lined with a highly refrac. mat. capable of being heated without disintegration to a temp. above the temp. of a charge of liquid glass at drawing temp. and of storing up such a degree of heat therein, heating such ladle while in inverted position by the application of flames concentrated with the ladle and projected from below directly against said lining so as to apply to and store up in such lining a degree of heat sufficient to maintain portions of a glass charge contained in said chamber and lying in contact with said lining in liquid condition during an entire ladling period, filling said ladle with a charge of molten glass at a temp. suitable for drawing a cylinder therefrom, pouring such charge into a heated drawing pot during a period while the portions of the charge in contact with the lining are kept liquefied and above congealing point by the abstraction by the charge from said lining of the heat stored therein, and then drawing a cylinder from such charge.





Means for drawing hot glass to glass tubes. WALTER RIEDEL. U. S. 1,545,349, July 7, 1925. Means for the production of glass tubes by drawing, comprising in combination an endless band capable of traveling in one direction, gripping members mounted in pairs on the said band, so as to be capable of pivoting in the plane containing the axis of the glass tube, resilient means capable of coacting with the said gripping members for causing them to grip the tube, and gripping

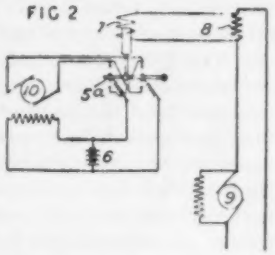
jaws on the said gripping members, which jaws lie in front of the pivotal points of the gripping members in the direction of travel of the said band, as and for the purpose set forth.

Glass and composition therefor. ROBERT J. MONTGOMERY. U. S. 1,545,508, July 14, 1925. A crown glass comprising antimony oxide in excess of 1% and less than 20%.

Glass and composition therefor. ROBERT J. MONTGOMERY and MURRAY R. SCOTT. U. S. 1,545,509. July 14, 1925. A cerium glass composition containing up to approximately 16% of antimony oxide.

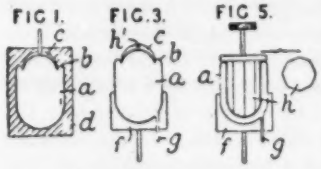
Glass-grinding apparatus. H. HART. Brit. Pat. 15 925(1923). In app. for automatically controlling the operation of glass grinding and polishing app. of the type in which the glass is laid on traveling tables and brought successively under a number of continuously working runners, the power taken by an elec. motor 9 driving the runners is maintained constant by a relay 5^a functioning to vary the speed of the runners or the press. of the runners on the glass. The relay is sensitive to potential variations across a resistance 8 in the motor circuit and controls a servo-motor 10, which derives power from a battery 6, and which adjusts a variable resist. in the shunt field of the motor 9. In the alternative form the relay 5^a energizes one or other of two electromagnets, which operate valves controlling the supply and discharge of water to or from tanks, the weight of which is borne by the runners.

FIG 2



Glass manufacture. GLASFABRIK SAPHIENHÜTTE R. BOCK GES. and W. HODECKER. Brit. Pat. 4879(1924). A method of making vacuum flasks consists in blowing a hollow glass body to the shape of the finished outer walls of the flask, and providing a domed portion thereon which is pushed inwards and shaped to form the inner wall of the flask.

FIG 1. FIG 3. FIG 5.



The hollow glass body *a*, Fig. 1, is blown in a mold *d* which is so shaped as to form the body with a shoulder *b* and a domed portion *c*. After removal from the mold, the body is held by tongs *f* and a narrow tube *g*, Fig. 3, is added to form the evacuation nipple. The dome *c* is then reheated, and the hole h^1, left by the blowpipe, is closed. A tool *h*, Fig. 5, preferably of polygonal cross-section, is then used to push the dome inwards to form the inner wall of the vessel, the body *a* and the tool *h* being rotated relatively to one another during this operation. In making a flask of the usual type with the neck narrower than the body, the tool *h* is provided with a portion that can be moved radially after the main portion of the tool has passed through the neck of the flask.

Heavy Clay Products

Brick maker's letter from America. J. H. *Tonind. Zeit.*, **49** [40], 558(1925).—Compares present German conditions with those in America in 1914 when $33^1/_3$% of the plants were closed and many were in receivers' hands. Describes the organization of the N. B. M. A. and State Associations. Gives the benefits derived and suggests similar plan for the Germans. Editorial comment agrees with the suggestion.

F. G. J.

Watersmoking in the ring oven. K. DÜMMLER. *Tonind. Zeit.*, **49** [40], 559 (1925).—Takes exception to a system proposed by Hielscher which does not warm the

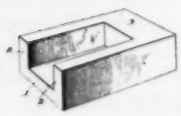
ware over 20° in 48 hours. D. proposes a design with the watersmoking flue above and a down draft through the ware. Illustrations are given. F. G. J.

Does it pay to modernize? E. J. WINKLEMAN. *Brick and Clay Record*, **66** [8], 590–1(1925).—This article contains suggestions of value in the ceramic manufacturers' remodeling or expanding programs. P. D. H.

Efflorescence on brick. ANON. *Brit. Clayworker*, **34**, 51(1925).—As the formation of efflorescence on bricks hastens the progress of decomposition, strenuous efforts should be made to overcome the troubles which is due to the influence of Na_2SO_4, Na_2CO_3 and $CaSO_4$. The alkalis come from the clay of which the brick are made. The SO_3 is absorbed by the brick during firing and subsequent cooling, principally from gases evolved throughout the process. The CO_2 is absorbed from the atmos. Before employing remedies it would be advisable to study the behavior of the different ingredients used, and observe how they are influenced by the gas fumes. The degree of fineness should be observed together with the sol. salt, SO_3 and S contents. In order to overcome efflorescence, experiments were made using a soln. of weak Fe_2Cl_6 soln. sprayed on a column of clay as this issued from a wire-cut mach. The firing of the brick was then conducted in the customary manner. The foregoing treatment was found to have improved the color of the bricks. The same could not be claimed for those which were treated with a $FeSO_4$ sol., the latter having proved unsatisfactory. Other experiments were tried applying a 20% sol. by means of a woolen covered roller which produced fair results. It is maintained that the employment of BaF_2 to overcome scumming offers advantages over other salts since it produces no harmful effects on the color and an excess is not harmful. The decompn. of the brick due to efflorescence can be reduced by washing off the crystals formed on the surface of the brick from this source.

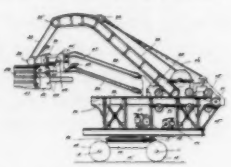
H. G. S.

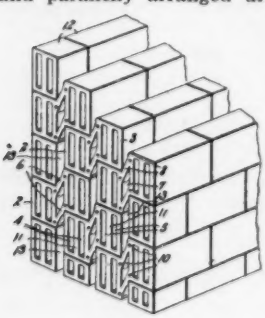
PATENTS



Brick. J. REGAN. U. S. 1,542,909, June 23, 1925. A building brick comprising an integral rectangular brick having a recess located centrally between the longitudinal sides of the brick, one end of the recess opening through one end of the brick and the other end of the recess terminating short of the opposite end of the brick, the cubical area of the recess being substantially one-third of the cubical area of the entire brick.

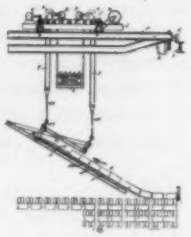
Gooseneck boom for bricksetters. G. E. LUCE. U. S. 1,543,214, June 23, 1925. In a device of the class described, the combination of a platform mounted for longitudinal movement, a frame rotatably mounted on the platform for movement in a horizontal plane, a crowding frame longitudinally movable with respect to said frame, a boom and parallelly arranged arms pivotally mounted on said crowding frame, a frame suspended from the boom and pivotally mounted on said parallelly arranged arms, a rotatably mounted brick carrier on said last named frame, an operator's seat on said suspended frame, and means on said suspended frame within convenient reach of the operator for rotating said brick carrier.





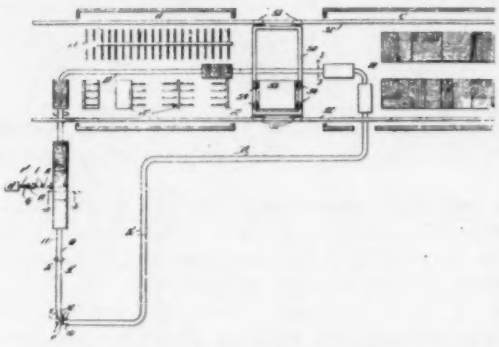
Building block. GLADYS E. WICKSON. U. S. 1,543,635, June 23, 1925. A building block, composed of integral hollow portions connected together by parallel walls extending angularly from the inner edge of the

bedding face of one hollow portion to the inner edge of the bedding face of the other portion, said walls retaining a space between them and the adjacent walls of the hollow portions, and a bead projecting from the outer side of each connecting wall adjacent each bedding face.

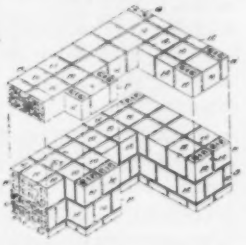


Apparatus for transporting and setting brick and the like. W. W. DICKINSON, JR. U. S. 1,543,752, June 30, 1925. A pallet for transporting and setting uniform rectangular blocks comprising a rigid rectangular platform having spaced grooves upon its upper surface adapted for the reception of said blocks in longitudinally abutting relation.

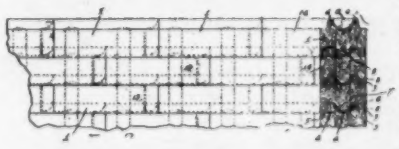
Apparatus for handling and transporting brick and the like. W. W. DICKINSON, JR. U. S. 1,544,819, July 7, 1925. In a device of the character described, the combination with a conveying belt, of transporting mechanism extending past said belt, trays or pallets carried by said mechanism and movable thereby in a direction parallel to the plane of said belt, and means for inclining said pallets during the period of their passage by said belt, whereby they may become filled with the articles delivered by said belt.



Hollow building block and system of wall construction. FREDERICK T. HEATH. U. S. 1,544,577, July 7, 1925. A hollow building block the edges of which define a cube and having an outer shell forming four sides thereof and interior transverse double webs connecting the shell walls, the webs being spaced apart a distance equal to the thickness of a mortar joint and forming with the shell a plurality of theoretical smaller cubes having the theoretic shell walls thereof joined by portions of the outer shell and of the transverse webs which portions are of a width corresponding to the thickness of a mortar joint.



Building block. JOHN TROST. U. S. 1,545,173, July 7, 1925. A building block comprising a body formed with longitudinal upstanding ribs at its upper side forming between them a longitudinal channel, said body being formed at its lower side with a longitudinal groove of a width to receive said upstanding flanges of an adjacent block, and also formed with a longitudinal rib within said groove to engage within said channel of an adjacent block with a narrow space between the surface of the channel and the surface of the rib, whereby when said blocks are placed, one upon another, mortar placed in said channel will be spread and distributed therein by the placing of the block above.



Refractories

On the relation of softening points of the raw materials used in the refractory industry. (Notes on the paper by Hirsch, *Tonind. Zeit.*, **49**, 21.) HANS NAVRATIEL.

Tonind. Zeit., **49** [37], 517(1925).—Load tests of refracs. at high temps. are uncertain because so many factors play a rôle. Tests were made under constant load of 1 kgm. per sq. cm. on a Steger press. Temp. was raised 4° a min. from 1000°C to the deformation of the cylinder. A curve was found which at first mounted becoming even flatter, then bent down and then fell, at first slowly, then more or less rapidly. A softening interval was thus measured. It was from the point where the curve began to flatten to horizontal. The temp. of this point is the deformation temp. The end-point was when the cylinder had been compressed 2 mm. or 4%. This point has less significance in practice. Results were:

	Beginning of softening	Point of change	Compression 4%
Wildstein			
Fired cone 14	1360°C	1450°	1600°
Saarau			
Fired cone 14	1490°C	1550°	1650°
Fired cone 17	1520°C	1570°	1660°

F. G. J.

The development of the German refractories industry since 1871 and its present status. ANON. *Tonind. Zeit.*, **49** [43], 589(1925).—Gives statistics of production and exports. F. G. J.

Materials of construction for very high temperatures. H. VON WARTENBURG. *Fuels and Furnaces*, **3** [7], 699(1925).—(Translated from *Chem. App.*) Considers the possibilities and limitations of carbon, zirconia, fused silica, hard porcelain, Marquardt's mass, platinum, 30% iridium-platinum, iridium, tungsten and tantalum. F. G. J.

Quartz glass and silica ware. J. B. C. KERSHAW. *Industrial Chemist*, **1**, 208 (1925).—The production of oxygen and hydrogen gases by electrolysis and their application in the arts and industries: The earliest attempts to fuse quartz and to manufacture tubes and other articles of quartz glass were carried out over twenty years ago with oxy-hydrogen flame, by Boys of England and Heraus of Germany. As quartz melts at about 2000°C, it was found quite possible to manuf. small lab. vessels and tubes in this way, and the manuf. of these soon attained considerable proportions, owing to the remarkable properties of quartz glass, the chief of these being its ability to stand sudden changes of temp. without breakage. It was impossible, however, to produce flasks or beakers of quartz glass with the aid of oxy-hydrogen flame, and it is only since the application of the elec. resistance fur. to the manuf. that the industry has developed on a large scale. Quartz glass can now be melted and blown just as ordinary potash glass, and the oxy-hydrogen flame is only employed for building up more complicated app. from the quartz glass tubes and the circular vessels which have been produced by the elec. fur. method. O. P. R. O.

Magnesite and dolomite. Tasmania. P. B. NYE. *Indus. Australian and Min. Stand.*, **73**, 612(1925).—A large deposit of dolomite and magnesite, suitable as regards quantity and probably as regards quality has been discovered in Tasmania. A more detailed examination is necessary before its commercial value can be detd.

O. P. R. O.

Welch brick industry. J. HORTON. *Iron Trade Review*, **76**, 1520–1(1925).—Silica brick produced in S. Wales approximates 36 million annually. About a third of the production of this grade of brick is used in Wales, while the rest is shipped to England, Scotland and Europe. Districts producing silica brick in S. Wales include Kidwelly, Penwyllt, Hirwaun, Dowlais, Templeton, Llandebie, Brynamman and Black Mountain. Of these Kidwelly is by far the most important, having the largest kilns in Great Britain. A short description of the brickmaking process in that district is given. H. H. S.

PATENTS

Heat-insulating composition. L. CALDWELL. U. S. 1,544,215, June 30, 1925. As a new article of manuf., a compn. comprising an inorganic heat insulating mat., a vegetable gum capable of forming a gel with water and a distending agent.

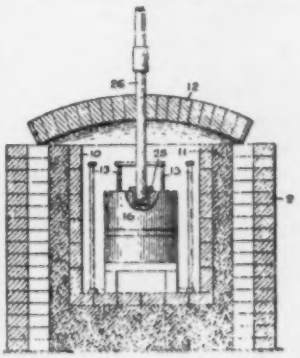
Semi-refractory heat-insulating composition, products and processes of making the same. H. T. Coss. U. S. 1,544,433, June 30, 1925. A refrac. heating insulating mat. consisting principally of silica in the form of tridymite, produced by calcining fabricated bodies made of a mixt. of diatomaceous earth, a catalytic inversion agent and water.

Heat-insulating composition. C. S. TIETSWORTH. U. S. 1,544,196, June 30, 1925. A heat insulating compn. comprising diatomaceous earth, a binding agent, an organic gum capable of forming a gel with water, a fibrous mat., and a distending agent.

Separation of magnesia from dolomite. F. W. BROWN and G. L. AUSTIN. U. S. 1,544,800, July 7, 1925. The process of separating magnesia from dolomite which comprises calcining dolomite, adding calcium chloride, treating the mixt. with sulphuric acid to form calcium sulphate and magnesium sulphate which will react with the calcium chloride present to form magnesium chloride and additional calcium sulphate, and separating the precipitated calcium sulphate from the soln.

Porous refractory article and method of making the same. MINER L. HARTMANN. U. S. 1,545,559, July 14, 1925. A porous refrac. article, containing previously burned porous crystalline aggregates.

Process of shaping fused silica. E. THOMSON and H. L. WATSON. U. S. 1,546,266, July 14, 1925. The process of making shaped articles having the properties of fused silica which consists in filling a mold with a mass of particles of substantially pure crystalline silica and heating the mass throughout to a temperature sufficiently high to convert said silica to the vitreous state, causing expansion, and to cause coalescence of the particles and shrinkage counteracting said expansion.



Refractory articles. H. WADE. Brit. Pat. 19,626 (1923). Hollow refractory containers are made from a composition containing graphite in excess of 15% and a ceramic bond also in excess of 15%, and are burnt at a temperature exceeding 2000°F to vitrify the bond. According to an example, 15–65 parts of graphite, 15–50 parts of clay and 5–15 parts of siliceous material are mixed and burnt until the bond is vitrified (at least 2000°F). Other refractory materials, as alumina, silicon carbide, zirconia, may be employed in addition. Fluxes, such as dolomite, or magnesite, may be added, and on burning produce a glaze on the articles.

Whitewares

The making and firing of glazed ware. XIX. ANON. *Brit. Clayworker*, **34**, 40–1(1925).—An account is given of the following subjects in this article: (1) Glazes containing SnO_2; (2) white glazes containing ZrO_2; (3) white opaque glazes containing ZnO; (4) white opaque glazes containing As_2O_5; (5) white opaque glazes containing TiO_2. H. G. S.

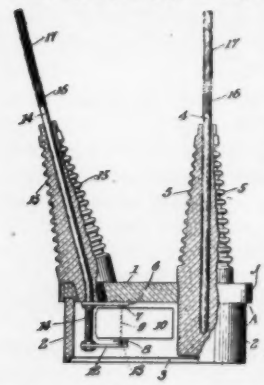
Glazing machines for wall tile. J. MÜLLER. *Keram. Rundschau*, **33**, 331(1925).—In some early types of glazing machines the tile were set on boards. These passed underneath a spray of the glaze by means of rollers. The glaze sprayed on the tile in this manner was pocket like and when fired had a wave-like appearance. Later the

boards were replaced by wire ropes. By using the excess glaze over again many impurities were introduced and it was found too costly to throw the same away. Ten to fourteen thousand tile can be sprayed by one man per 8 hr. day using this process. About 5 h.p. are required to operate this machine. Later the Goldsmith process (American) was developed in which the tile were dipped in the glaze. The thickness of the glaze produced by this process depended upon the absorption of the tile, those which are vitreous will have a thinner coating than those which are more porous, which is therefore undesirable. The more modern machines apply glaze to the tile by means of flushing. Most of the small as well as large plants now have glazing machines even though they cost considerable since they are patented. Ten thousand tile can easily be glazed per hour with this machine. The glaze flows in a steady stream on the tile and the glaze is applied uniformly regardless of the porosity. The advantage of this method of spraying can readily be seen by comparing tile coated in this manner with those glazed by spraying. Only two men are required to operate this machine and the tile are put in saggers as they come from the machine. H. G. S.

Porcelain funnels. F. MAYER. Ger. Pat. *Industrial Chemist*, **1**, 52(1925). (*Zeit. für Ang. Chemie*, Nov. 27, 1924).—Porcelain funnels for filters to be kept warm or cold. In this new app. the walls are hollow and have openings for the entrance and exit for hot water and vapor. Heat is conveyed direct to the filtrate, and as porcelain has a high specific degree of heat, it does not cool owing to a temporary interruption of the heating. Expts. have shown that a temp. of 70° is soon conveyed to the filtrate when boiling water is used. The effect is increased by covering up the spout of the funnel with a watch glass. As the Bunsen heater at the side of the ordinary funnel is eliminated, combustible fluids can be heated without any danger of ignition. It is also suitable for filtrates requiring a low temp., obtained by means of cold-producing mixts., so that it can be used for fluids or ppts. that are affected by heat. It can also be used for any ordinary purpose, so that it will not be necessary to keep a special filter. The funnel is made in three sizes, to fit a strainer 70, 90, 140 mm. O. P. R. O.

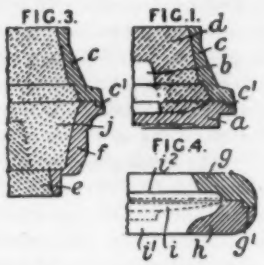
PATENTS

Instrument for locating and observing defective insulator units. C. E. BENNETT. U. S. 1,542,815, June 23, 1925. A portable defective-insulator detector and observation instrument which operates equally well in all positions for detecting and observing defective insulator units in a series of such units, or otherwise, subjected to a high voltage, comprising in combination, spaced apart conductors highly insulated from one another and from ground for taking the voltage at the opposed surfaces of the insulator unit or units being tested; a rockable balanced indicator element which is rockable from a normal zero position to which it is constrained to return when free of electrostatic stresses to another observable position by the action of the electrostatic field resulting from the difference of voltage between the two conductors; a shield of conducting mat. for adjusting the strength and form of the electrostatic field in which the indicator element moves; a casing for maintaining the above elements in their correct relative position and for protecting the indicator element from undesirable outside influences.



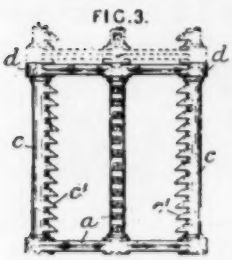
Pottery. J. H. JACKSON, J. A. JACKSON, J. S. JACKSON and J. JONES. Brit. Pat. 7688(1923). App. for casting plaster pottery molds comprises a pair of open-ended, annular elements adapted to inter-engage by a rabbeted connection from which the

formed mold may be removed by separation of the parts. Fig. 3 shows one form comprising elements *c*, *f* having a rabbeted connection c^1. The element *f* supports a "lump" or pattern *e* above which plaster *j* is filled in to form a "block" for throwing. After molding the block *j* may be trimmed or cut away. The "lump" *e* is formed by casting plaster in a mold *d*, Fig. 1, which is formed by running in plaster around a pattern *b* carried by or integral with a disc *a* adapted to be surmounted by the element *c* and also formed with the rabbet c^1. Fig. 4 shows a modified apparatus for producing flat pressing molds which comprises shallow elements *g*, *h* interengaging at g^1 and adapted to receive a plate *i* above and below which are spaces i^1, i^2 to receive the plaster.



Enamels and glass. General Electric Co., Ltd. Brit. Pat. 14,532(1924). Glasses or enamels having a low melting-point consist of a lead borate or lead borosilicate composed of a number of constituents in accordance with the following molecular composition: PbO, 1; B_2O_3, 0.45 to 0.55; SiO_2, 0 to 0.20; Al_2O_3, 0.04 to 0.20; Na_2O, 0.04 to 0.07; K_2O, 0.01 to 0.02; As_2O_3, 0 to 0.01; Co_2O_3, 0 to 0.04. The Co_2O_3 may be replaced by other coloring or opacifying agents. The mixture fuses at a temperature below 400°C, generally between 360°C and 400°C. These enamels are suitable for marking electric lamp bulbs, their low fusing-point preventing the thin glass bulbs from becoming deformed while the enamel is being burnt on. They are also suitable for use as an adhesive between metal, glass, porcelain and the like. They may be used, also, for coating metal or glass bodies by heating the bodies and dipping them while hot into the powdered enamel. Specification 28524/03 is referred to.

Supports for pottery. J. E. Tams, W. H. Edwards and W. T. Connelly. Brit. Pat. 15,100/23(1923). Cranks for supporting pottery during firing consist of a metal base *a* with sockets into which are fitted three vertical clay, fireclay or like rods or supports *c* having integral knife-edged projections c^1. An upper plate *d* similar to the base may connect the tops of the rods.



Equipment and Apparatus

Design, construction and use of a constant humidity room. R. G. Parker and D. N. Jackman. *Jour. Soc. Chem. Ind.*, **44T**, 223(1925). H. H. S.

Kilns, Furnaces, Fuels and Combustion

Down-draft rectangular kilns. H. de Witt. *Rev. Mat. Constr. Trav. Pub.*, **188**, 103–6B(1925).—Plans and sketches are given of two types of kilns, differing only in the method whereby the products of combustion are removed. The arch spans two parallel walls in which are situated the fire boxes. The two remaining walls are built separate from the rest of the kiln and each contains a doorway. The flames from the fire boxes are made to rise immediately to the crown of the kiln over bag walls which reach to the foot of the arch. The heat then passes down through the ware and into openings in the floor. Type 1 kiln has two modifications: (*a*) the openings in the floor are arranged in rows which lead to a common large flue running at right angles to the rows of openings. The flue is centrally located running underneath and between the two doorways and connected to a stack at one end. The draft on the sections of the kiln must be balanced by the partial covering of the openings in the floor. The porcelain

plant at Sèvres has lately installed such a kiln. (*b*) In the second modification the central flue leads to two stacks each located near a doorway. The draft is then controlled by dampers. In type 2 there is no central flue. Each row of openings in the floor leads to two small stacks located at the ends of the row in the side walls. The stacks flank the fire boxes giving for a small kiln 4 stacks and 3 fire boxes on each side. Each stack has its own damper. Such a kiln may be made quite long and yet maintain complete control of the firing. A similar kiln near Paris has 30 fire boxes and is used for the firing of flower pots. L. N.

The coking and swelling constituents of coal. FRANZ FISCHER. *Ind. and Eng. Chem.*, **17** [7], 707(1925).—Extraction of coal with benzene at 250°C yields an extract which can be divided into two main components by means of gasoline. One is oily and soluble, the other, solid, brown, insoluble. The oily body is the principal source of the coking quality of coal. The solid body, which is decomposed by heat with gas evolution is the principal cause of the swelling of coal. The relative amounts of each varied with the age of the coal. Expts. were made on the coking and swelling of coals from which these constituents had been partly or wholly extracted and to which they had been separately returned. F. G. J.

Auxiliary equipment for oil burning. KESTER MILLER. *Fuels and Furnaces*, **3** [7], 707(1925).—A discussion of oil heaters, meters and valves for the edification of operators of fuel oil systems. F. G. J.

Reactions in the fuel bed of a gas producer. R. T. HASLAM, F. E. ENTWISTLE AND W. E. GLADDING. *Ind. and Eng. Chem.*, **17** [6], 586(1925).—Gas samples were withdrawn from the fuel bed of gas producer, precautions being taken to prevent channeling of the gases and to stop reactions once the gases entered the sampling tubes. Analyses showed: (1) The oxygen is first completely consumed in a very thin zone with the formation of carbon dioxide. (2) No water is decomposed and only a small amount of carbon monoxide is formed until all the oxygen is consumed. (3) Steam is reduced by the solid carbon fuel only in the lower portion of the reducing zone, immediately above the oxidation zone. Carbon dioxide is also largely reduced within this zone. (4) Above this zone the only water decomposed is by the reaction, $CO + H_2O = CO_2 + H_2$. Simultaneously some carbon dioxide is reduced by carbon. F. G. J.

Preheating chambers. ANON. *Brit. Clayworker*, **34**, 54(1925).—To insure high efficiency from fuel, a sufficient number of preheating chambers should be employed on continuous kilns to utilize the waste heat from cooling kilns. The number of chambers to be employed depends upon the temp. of the kilns when heated to their maturing point. For example, a kiln heated to 950°C will not supply sufficient heat for a large number of preheating chambers whereas once heated to 1200°C will supply sufficient heat for a larger number of heating chambers. Another fact which affects the number of chambers is the dampness of the contents. To raise the temp. of a perfectly dry brick to 100°C requires only 14 heat units, but to remove 1 lb. of H_2O from a brick requires nearly 1000 heat units, and even then the temp. of the brick would not be increased. Unless the brick are perfectly dry a large number of preheating chambers cannot be used. The closeness with which the brick are set may also effect the number of preheating chambers. The temp. of the gases at the base of the chimney of a continuous kiln ought never to be less than 100°C and that of the gases leaving the kiln chambers and entering the main flue ought not be less than 120°C; yet in many kilns they are much less than this—with the results, that brick are scummed or cracked or the output of the kiln is so low as to make the manuf. unprofitable. Assuming that the finishing temp. is 950°C it ought to be easy to pass the waste gases through at least four chambers before the temp. has dropped to 120°C. The use of a fan to drive the heat through chambers may permit the use of a greater number. Many continuous

kilns are so short that they do not admit of a sufficient number of chambers being used for preheating; with such a kiln the possibility of adding more chambers is always well worth consideration, as broadly, the number of chambers is inversely proportional to the consumption of the kiln. H. G. S.

Method for sampling coal cargoes. F. H. WALKER. *Jour. Soc. Chem. Ind.*, **44T,** 283–5(1925). H. H. S.

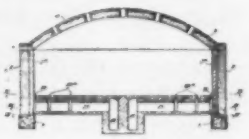
Inorganic constituents of coal. R. LESSING. *Jour. Soc. Chem. Ind.*, **44T,** 277–83(1925). H. H. S.

The constitution of coal. W. A. BONE. *Jour. Soc. Chem. Ind.*, **44T,** 291–9 (1925). H. H. S.

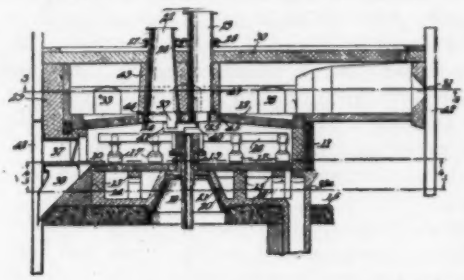
Economic feature of heat-exchanger design. F. L. MAKER AND M. W. THORNBURG. *Mech. Eng.*, **46,** 891–5(1924).—The economical area of a heat interchanger is that area beyond which the cost of additional surface (overhead, maintenance and profit) is more than the value of the heat saved. Equations are derived for solving such problems. Graphic charts are developed for quick solns. (*C. A.*)

PATENTS

Brickkiln. O. M. REIF. U. S. 1,544,599, July 7, 1925. In a down-draft brick kiln, a floor divided by narrow elongated outlet ports into substantially rectangular sections, said sections being adapted to receive and space apart rectangular stacks of bricks to be fired, and draft passages connecting said ports to an outlet stack.



All-ceramic furnace. O. BEZANSON. U. S. 1,544,798, July 7, 1925. In a fur. of the type for carrying out chem. processes involving the interaction of corrosive mats. at high temps., the combination of a reaction chamber having a bottom, side walls and a roof of ceramic mat., a combustion chamber including as its bottom the roof of the reaction chamber, a gas pipe and a feed pipe extending centrally up from the reaction chamber through the combustion chamber, and means situated above the combustion chamber for supporting the said pipes.



BOOK

The conversion of coal into oils. F. FISCHER. Trans. and Ed. by R. LESSING. Pp. XIII + 284. London: E. Benn, Ltd., 1925. Price 36s. H. H. S.

Geology

Fluorspar prices. ANON. *Eng. and Mining Jour.*, **119,** 1034(1925).—Conditions are said to be unsatisfactory in the U. S. market, whether judged from the viewpoint of producers or of consumers. The weighted average for all grades is around $20.00 per ton as compared with $7.00 before the war, but producers state increasing costs of labor and deep mining have more than offset the higher price. There is said to be much unemployment in the fluorspar mining districts. Consumers are encouraging foreign source of supply, notably a very pure acid-grade feldspar from Transvaal. H. H. S.

The Russian manganese concession. ANON. *Eng. and Mining Jour.*, **119,** 1033–34(1925).—The Mn district of Chiatouri, Russian Georgia, has been conceded to the Harriman Co. of N. Y. There are three chief sources of Mn in the world, India, Russia and Brazil. The U. S. has relatively small Mn resources. H. H. S.

Foshagite, a new silicate from Crestmore, California. A. S. EAKLE. *Am. Mineral.*, **10,** 97–9(1925).—Foshagite, named in honor of W. F. Foshag, was found with vesuvianite, calcite and thaumasite at the Wet Weather quarry. Its properties are: color, snow white; luster, silky; structure, compact fibrous; hardness = 3; sp. gr. = 2.36; analyses gave: SiO_2 33.92, Fe_2O_3 0.83, CaO 53.48, MgO tr., CO_2 1.83, H_2O 10.19, sum 100.25%; formula, $H_2Ca_5(SiO_4)_3\ 2H_2O$; fibers have // extinction and + elongation; $\alpha = \beta = 1.594$; γ 1.598; optically +. (*C. A.*)

Bauxite deposits of British Guiana. L. T. EMORY. *Eng. Mining J.-Press,* **119,** 686–9(1925).—Bauxite occurs through an area along the edge of the foothills from the Essequibo to the Courantyne River. The deposits have been worked since 1917. The bed averages 16–20 ft. in thickness, and the deposit is frequently so uniform in compn. and low in Fe and Si that it can be mined by steam shovel. (*C. A.*)

An enormous magnesite deposit in Manchuria. HIRONAO NISHIHARA. *Eng. Mining J.-Press,* **119,** 488–9(1925).—Magnesite is being mined 3 miles southeast of Tashihchiao. It occurs in beds alternating with dolomite and slate. Two analyses gave 90 and 96% $MgCO_3$. At Pai-Lo-Shan a coarse cryst. mass 780 ft. thick is exposed. An est. of 300 million tons of magnesite above ground level is made. (*C. A.*)

BOOK

RUMBOLD, W. G.: **Bauxite and Aluminium.** Monographs on Mineral Resources with Special Reference to the Brit. Empire. London: John Murray. 6s. net. (*C. A.*)

Chemistry and Physics

Potash from sea water. E. NICCOLI. *Giorn. Chim. Ind. Appl.*, **7,** 187–94(1925).—The removal of K salts from sea water is accomplished in three parts. Concentrating to 34–35 Bé., the impure salts separate out. At 37–38 Bé. $MgSO_4$ of commercial purity is produced. At 42 Bé. $MgCl_2$ as a solid product is formed of the Stassfurt type. The liquors contain about 20% KCl. The second phase is concentrating the K_2SO_4 and $MgSO_4$ to 97–98% purity. The third phase is treating with lime and leaving K_2SO_4 of 94–96% purity. A large number of analyses of various sea water as to the compn. of the solid mats. in the water and the percentage of solid material in the water. The process described is used in Tripoli on the Mediterranean and the sun is used to furnish part of the heat for evaporation. S. S. C.

The effect of grinding on the density of quartz. R. B. SOSMAN AND H. E. MERWIN. *Jour. Wash. Acad. Sci.*, **14,** 117–8(1924).—Quartz ground dry to 40mu and finer showed under microscope to still be quartz and after grinding under water it still remains the same. This work was done in an attempt to check the work by Ray who showed the density to be lowered in about $^1/_3$ of the material which was said to be converted to an amorphous form. S. S. C.

Sodium chromate. N. JOUSHKEVITH. *Trans. Inst. of Economic Mineralogy and Petrology* (*Moscow*), No. 13, 1925.—Obtainment of sodium-chromate by roasting of chrome iron ore with calcinated soda and caustic lime. Experiments have been made in order to study influence of temp. on the velocity of production of chromates. Results show formation of chromates at 700°C is rather slow; but is apt to leap at higher temps. At 1160°C it is so great that one-half hour's roasting is sufficient to convert 95% of Cr_2O_3 into chromates. The oxidation of chromium proceeds, under usual industrial conditions, with equal velocity during the whole process of roasting, $7^1/_2$ hrs. It is therefore evident that the temp. of the mass gradually and constantly increases throughout the opern. A fur. adequately constructed for the roasting of the mixt. should answer the following conditions: (1) the mixt. must be rapidly heated up to 1160°C; (2) the mixt. must be constantly and mechanically stirred; (3) the temp. of the heating gas must not exceed 1260°C. To heat the mixt. rapidly up to 1160°C place it in a shelf-furnace

in thin layers and heat from the upper surface by hot gases directly and through the shelves from the bottom, the stirring being operated continuously. Temp. of the gases to be kept at high range. O. P. R. O.

Measurement of air temperature in closed spaces with thermometers not protected from radiation. H. HAUSEN. *Sci. Abst.*, **28** [4], 308(1925); *Zeits. techn. Physik*, **55**, 169–86(1924).—The paper is concerned with the errors introduced in the measurement of air temp. when freely exposed thermometers are used in the presence of neighboring bodies whose temp. differs from that of the air in which the thermometers are placed. The first section is devoted to a mathematical investigation of the error, taking into account radiating bodies and thermometer bulbs of different sizes and forms. Formulas are obtained for the "radiation error" and its numerical magnitude is evaluated for certain cases. It turns out that it may be quite large. For example, in a room, the walls of which are at a temp. of 10°C, a mercury thermometer with bulb diameter 0.55 cm., will, at a point where the air temp. is 20°C, read about 2.7°C too low. On the other hand, in the presence of a hot surface 1 m. high and broad, with a temp. of 60°C, the same thermometer in air at 20°C will read about 5°C too high at 11 cm. distance from the heated surface, 2°C at 0.4 m. and about 0.25°C at 2 m. distance. Means of reducing or avoiding such errors are next considered. They may be considerably reduced by gilding or silvering the bulb, the reduction being considered numerically in the paper. But the most effective way (apart from using a shielded thermometer, such as an Assmann aspirated thermometer) is to use a pair with bulbs having different radiation constants, such as a plain glass one and a silvered one. A simple formula enables the correction, which must be applied to either to get true air temp., to be deduced from the difference between the readings of the two thermometers. Then follows a section setting out the results of expts. giving satisfactory confirmation of the theory. An appendix includes a consideration of the effect of lighting, either natural or artificial, and of the proximity of the human body when reading. Remarks are also made on the best method of exposing and supporting room thermometers. A. F. G.

Stability of kaolin suspensions. W. O. KERMACK AND W. T. H. WILLIAMSON. *Proc. Roy. Soc. Edin.*, **45**, 59–70(1924–5); *J. Soc. Chem. Ind.*, **44B**, 464(1925).—Comparison was made of the rates of sedimentation of a kaolin suspension in solns. of differing pH value, in presence of varying concns. of each of the following salts: NaCl, KCl, Na_2SO_4, Na_2HPO_4, Na citrate, $CaCl_2$, $CaSO_4$, $CaHPO_4$, $AlCl_3$, $FeCl_3$, $LaCl_3$ and superphosphate. In general, the metal ion assists the pptg. action of the H ion. NaCl, however, while increasing sedimentation in alk. soln., decreases it in acid soln., and Na_2SO_4 acts similarly, their behavior being ascribed to chemical reaction. The tervalent ions, Al, Fe and La, in acid solns. have very little effect, but a zone of marked flocculation occurs at pH 7–8. Abnormal pptn. occurs with $CaHPO_4$ and superphosphate in alk. soln., probably due to deposition of basic $Ca_3(PO_4)_2$ on the kaolin particles. H. H. S.

Dispersion and base exchange in clay. G. WIEGNER. *Koll. Z.*, **36**, *Zsigmondy-Festschr.*, 341–69(1925); *J. Soc. Chem. Ind.*, **44B**, 464–5(1925).—The charge on clay particles is ascribed to the presence of a complex silicate anion holding in equilibrium a sheath of cations by residual electrostatic forces. The attractive force on these cations increases with increased valence, and decreases with increased hydration. Ultra microns with heavily hydrated cations like Li and Na are bulky and viscous and resemble hydrophilic colloids; those with less hydrated cations like Ca and Cs are less viscous and resemble hydrophobic colloids. Simple effects of added electrolytes are obtd. only if the added cation is the same as that in the outer sheath of the colloid particle; in other cases flocculation always includes base exchange. Owing to base exchange a small amt. of KCl, added to a large amt. of a calcium clay, has the same

flocculating effect as an equiv. amt. of $CaCl_2$, and Schulze's law is thus invalid. The changes in the relative flocculating powers of uni- and bi-valent ions with varied colloid concn. probably depend on changes in the amounts and relative importance of the exchanged bases. H. H. S.

Spectroscopy and its relation to chemistry. H. DINGLE. *Jour. Soc. Chem. Ind.*, **44,** 602–3(1925). H. H. S.

Separation of zirconium and hafnium from titanium, cerium and thorium. L. MOSER AND R. LESSING. *Monatsch.*, **45,** 323–7(1924); *Jour. Soc. Chem. Ind.*, **44B,** 481(1925).—Zr and Hf are separated quantitatively from Ti, Ce and Th, by pptn. as basic arsenate from strong HNO_3 soln. contg. H_2O_2 by addn. of sodium arsenate. H. H. S.

Critical studies on methods of analysis. XV. Magnesium. L. A. CONGDON AND G. VANDERHOOK. *Chem. News,* **130,** 241–3, 258–61, 273–6(1925); *Jour. Soc. Chem. Ind.*, **44B,** 480(1925). H. H. S.

Gravimetric determination of aluminum and its separation from manganese by "infusible white precipitate" ($ClHgNH_2$). B. SOLAJA. *Chem. Zeit.*, **49,** 337–8 (1925); *Jour. Soc. Chem. Ind.*, **44B,** 480(1925). H. H. S.

Magnetic ferric oxide. H. ABRAHAM AND R. PLANIOL. Meeting Fr. Acad. Sci., May 4. *Nature,* **115,** 930(1925).—Ordinary Fe_2O_3 (colcothar) is non-magnetic, but if Fe_3O_4 be heated in air at 200–250°C so that oxidation proceeds slowly and without incandescence, the resulting Fe_2O_3 is brown and strongly magnetic. At 700° this oxide becomes red and non-magnetic. H. H. S.

Separation of celtium and zirconium. M. MARQUIS, P. URBAIN AND G. URBAIN. Meeting Fr. Acad. Sci., May 11. *Nature,* **115,** 930(1925).—Fractional pptn. with satd. solns. of Na_2CO_3 gives the best separation. H. H. S.

Colorimetric determination of hydrogen-ion concentration. E. RICHARD. *J. Pharm. Chim.*, **1,** 328–33(1925); *J. Soc. Chem. Ind.*, **44B,** 480(1925).—Equal vols. of an appropriate one-color indicator are added to 10 cc. of the sample and to 10 cc. of $N/100$ NaOH. After 2 or 3 min., the colors are compared in a colorimeter, and the pH is calcd. from the formula $pH = K + \log E/(e - E)$, where E is the colorimeter reading for the NaOH, e the reading of the sample, and K a const. depending on the indicator. A series of constants are given for indicators ranging from pH 2.2–12.0. If $E/(e - E)$ is less than unity, the formula $pH = K - \log (e - E)/E$ is used instead of the above. H. H. S.

The photography and measurement of fine particles. HENRY GREEN. *J. Ind. Hyg.*, **7,** 155–65(1925). (*C. A.*)

Solid solutions. G. BRUNI. *Chem. Rev.*, **1,** 345–75(1925).—A lecture, reviewing the historic development and the present state of knowledge under the following headings: Diffusion in the solid state, heat of formation, constitution of solid solns., applicability of the law of solns. to solid solns., solid solns. and chem. combination. Numerous references are given to original papers. (*C. A.*)

Bentonite as a one-dimensional colloid. E. T. WHERRY. *Am. Mineral.*, **10,** 120–3(1925).—Bentonite contains plates of a biaxial substance, having microscopic breadth, but probably colloidal thickness. The characteristic swelling, adsorptive power for dyes, and plasticity of bentonite may well be due to this peculiar dimension-relation of the grains and the consequently great surface exposed. (*C. A.*)

Studies of living organisms from the point of view of geochemistry. V. I. VERNADSKII. *Bull. acad. sci. Russie,* **1921,** 120–3; cf. *C. A.*, **17,** 2099.—During the investigation of the decompn. of clays by living organisms, a culture of *Nitschia* was isolated. It seemed to have a definite action on soils. V. recommends detns. of the metal and rare earth content of living organisms. (*C. A.*)

A tabulation of the aluminium silicate minerals. E. T. WHERRY. *Am. Mineral.*, **10,** 140–5(1925).—A series of Al silicate minerals is plotted in a new type of triangular diagram, the minerals being selected on the basis of their Si:Al ratios falling into the harmonic series N-3. Colloidal, meta-colloidal and crystd. representatives of each ratio are given as probably comprising the existent mineral species. Dana's bauxite, schrötterite and montmorillonite are omitted, but many of his varieties are made species. Some of the new species are quite abundant. Further work on correlating optical and chem. properties in such minerals is needed. (*C. A.*)

Dissociation of magnesium carbonate in stages. M. TZENTNERSHVER AND B. BRUZS. *Z. physik. Chem.*, **114,** 237–50(1924).—The thermal dissociation of magnesite has been studied by a dynamic method (cf. *C. A.*, **18,** 3501), which permits of a complete sepn. of the dissociation products. The substance is heated in a Ni boat in an elec. furnace, and the temp. and pressure are measured. The dissociation temp. is detd. from the form of the heating and cooling curves. Kahlbaum's pure $MgCO_3$, which had been dried for 3 days at 220°, in a stream of CO_2 began to dissociate at 270°, but on repeating the test the dissociation temp. rose to 368°. Water vapor came off during the expt., and it was shown that the disagreement was due to the presence of water of constitution in the sample of carbonate. The sample dried at 220° was therefore further dried at 320° in a stream of CO_2 for 3 days. The carbonate thus prepd. dissociated according to the following stages: (1) $2MgCO_3 = MgO.MgCO_3 + CO_2$; dissociation temp. 373°, under atm. pressure. (2) $2[MgO.MgCO_3] = 3MgO.MgCO_3 + CO_2$; dissociation temp. 442°. (3) $3MgO.MgCO_3 = 4MgO + CO_2$; dissociation temp. 469°. With natural rhombic magnesite, the stages were as follows: (1) $4MgCO_3 = MgO.3MgCO_3 + CO_2$; dissociation temp. 402°. (2) $MgO.3MgCO_3 = 2[MgO.MgCO_3] + CO_2$, or $2MgCO_3 = MgO.MgCO_3 + CO_2$; dissociation temp. 437°. (3) $MgO.MgCO_3 = 2MgO + CO_2$; dissociation temp. 480°. The first dissociation product of magnesite, monoxytricarbonate, is metastable. Expts. in which the completely or partially dissociated carbonate was heated in a stream of CO_2 between 200° and 230° showed that under these conditions the reverse formation of carbonate takes place extremely slowly. (*C. A.*)

BOOKS

A catalogue of British scientific and technical books, covering every branch of science and technology, carefully classified and indexed. Compiled by British Science Guild. New Ed., pp. xxii + 489. London: A. & F. Denny, Ltd., 1925. Price 12s. 6d. H. H. S.

Wolfram. H. ALTERTHUM. Pp. vii + iii. Brunswick: F. Vieweg u. Sohn, 1925. Price 4.50 M. Deals with the production and industrial application of tungsten, its alloys and compounds. H. H. S.

Tables annuelles de constantes et données numériques de chimie, de physique et de technologie. Vol. V. Pt. I. By commission permanente du Comité international. Paris: Gauthier-Villars & Co. Chicago: Univ. of Chicago Press. 804 pp. $25 (parts 1 & 2). Reviewed in *Mech. Eng.*, **47,** 389(1925).

WELLINGS, A. W.: **Chemical Symbols, Formulas and Calculations.** London: Meuthen & Co. 104 pp. 3s. 6d.

PATENT

Process of making aluminum chloride. ALMER MCDUFFIE MCAFEE. U. S. 1,544,328, June 30, 1925. The herein described process of making aluminum chloride which comprises treating aluminum containing mats. with chlorin in the presence of an activated carbon.

General

Operating the English clay pit. W. BARNES. *Brick and Clay Record*, **66** [8], 584–8(1925).—This is a complete description of the English clay winning methods

illustrated with a number of photographs. Oxford clay is the most important deposit of brick clay in England. At Peterboro and Bedford, beds over 100 ft. in thickness are being worked. The clay contains oil which greatly assists the firing. The capacity of the average English brick machine is from 100,000 to 120,000 brick per week. The smallest factory where it pays to use a mechanical excavator is one producing from 60,000 to 80,000 brick per week, requiring from 180 to 240 cu. yds. of mat. The smallest shovel in use is the three quarter cu. yd. With this shovel the depth of the working fan should not be greater than 25 ft. An interesting feature about the British design of excavator is the duplex rail wheels which dispense with the jack screws. The portion of the wheels near the framing is arranged for running on the standard 4 ft., $8^1/_2$ in. gage track, whereas the outer edge of the wheel has double flanges to enable the mach. to run on a gage of about 6 ft. 6 in. P. D. H.

Government tests and purchases. ANON. *Brick and Clay Record*, **66** [8], 580 (1925).—This article tells advertisers how they may properly refer to the Army, Navy or Bureau of Standards, to avoid misrepresentations or violations of policy. P. D. H.

The advancement of the French ceramic industry by the industrial management agreement between France and Germany. ANON. *Tonind. Zeit.*, **49** [38], 534(1925).—The importance of the change in the general tariff on German ceramic wares is shown by the following: (1) The development of the French ceramic industry whose capacity is three times that of prewar times. (2) The influence of the important factories in Alsace-Lorraine. (3) The condition of the Belgian industry which coöperates with the French. F. G. J.

The hazard of carbon monoxide to the public and to the industry. S. H. KATZ. *Ind. and Eng. Chem.*, **17** [6], 555(1925).—Carbon monoxide is likely to exist anywhere. It is insidious and asphyxial in character. Proper regulation of burners will reduce the amount formed. Small amounts in the air can be detected by a simple color test. Two new devices have been developed by the Bureau of Mines for the protection of persons obliged to work in the presence of carbon monoxide. Other results of recent research include a treatment for resuscitating persons overcome by this gas and the development of a simple test for determining carbon monoxide asphyxiation. F. G. J.

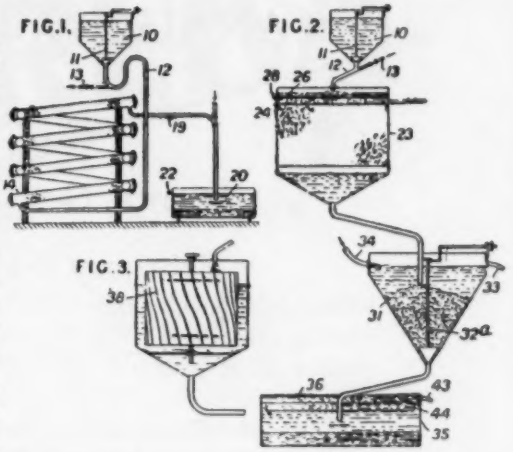
Radial distribution of certain elements in the earth. H. S. WASHINGTON. *Jour. Wash. Acad. Sci.*, **14**, 435–42(1924).—The center of the earth has a ferro-nickel core which is surrounded by a course of nickel, iron and silicate. The silicate usually is olivine $2(FeMg)OSiO_2$. This "lithosporic" shell changes to a "ferrosporic" with a metal content of not over 15%. Next is a 60–100 kilometer "crust" which is a mixture of $CaOAl_2O_32SiO_2$ and $Na_2OAl_2O_36SiO_2$. In the lower part of the crust little or no K_2O and Na_2O are present. The order of occurrence of substances from the surface is K, Na, Ca, Mg, Al, Fe and Ni. S. S. C.

PATENTS

Process of treating colloidal clay. ERNEST C. BIERCE. U. S. 1,544,210, June 30, 1925. The process of treating colloidal clay to produce a filtering and decolorizing mat. comprising drying the lumps of clay as they come from the quarry without any preliminary grinding or addition of water until its free water content is reduced to approx. 12%, adding mineral acid in the proportion of approx. 4% to the clay, further drying to reduce the free water content to about 5%, comminuting the clay to pass through a coarse mesh screen, adding 1% of mineral acid, screening the clay to separate the finer particles suitable for the contact process of filtration from the coarser particles suitable for the pecolation method of filtration.

Bleaching kaolin and the like. R. F. B. GAUDIN and DARTMOOR CHINA CLAY CO., LTD. Brit. Pat. 9964(1923). The treatment of kaolin or the like with a solution of sulphurous acid in presence of a metal such as zinc to remove impurities is effected

by causing a suspension of the kaolin to flow over an extended surface of zinc. The pulp from a container 10 may be fed by a valve 11 through a pipe 12 having an inlet 13 for sulphurous acid, and leading to the bottom of a series of connected inclined tubes 14 filled with pieces of zinc. The treated pulp is withdrawn by a pipe 19 to a settling tank 20 having an overflow 22. Alternatively the pulp may be fed to a chamber 23 containing a distributing device comprising pivoted perforated plates 24, 26, Fig. 2, one plate 26 being operable by a handle 28 to vary the size of the openings. The pulp then passes through a body of scrap zinc resting upon a false bottom and thence to a washing vessel 31 which receives wash water at 34 and overflows at 33. The pulp settling in the conical part of the vessel 31 is discharged by a valve 32ª to a settling vessel 35. The settling chamber 35 has an inwardly turned edge 36 extending over the edges of a tray 44 immersed in the pulp and covering the depositing clay. The overflow 43 is above the edge 36. In another modification, the suspension is passed through a vessel containing a grid or structure 38, Fig. 3, of zinc.



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EDITORIALS

USES OF CERAMICS IN INTERIOR DECORATING

An Interview with Lionel Robertson of Tobey Furniture Co.

By Myrtle Merritt French

Too often a producer manufactures without knowing exactly what is needed and then wonders why his ware does not sell. Meanwhile those who would naturally be using the product are buying from foreign nations, after giving up hope of finding in this country articles of the desired quality. An interior decorator in the John Smyth Furniture Company told me sometime ago that his concern keeps at least one man abroad the year around buying pottery for their work, because artistic enough things are not available in this country. What is true of one company is doubtless true of another. If the statement is correct we have it within ourselves to rectify it. In many instances, both the producer and consumer blame the "other fellow" for the situation, but the only way to make amends is for those concerned to get together. Here is a new kind of research which is needed worse than almost any other in the ceramic field. After all, the producer (and most of us are producers) is more vitally interested than the consumer and therefore should take the initiative. The first step is to discover what our would-be consumers could use.

Knowing that Lionel Robertson of Tobey Furniture Company is extremely interested in uniting the efforts of the artist with those of the in-

dustries and that he has already accomplished much along that line, I asked him to tell how he is using ceramics for interior decoration. Generously, he told of his very definite ideas as he is working them out so successfully in the homes of Chicago.

"Pottery is one of the most valuable items used in making up a beautiful composition for interior decoration. In planning a composition a decorator must play up to contrast. It is that interesting play of contrast of one against the other that gives life to the whole room. That is, contrast of color and contrast of texture, which is equally necessary. Here is where ceramics plays an important rôle. We have our rugs, furniture covers and curtains, which have softness of texture; ceramics comes in with hard glazed surfaces and gives an interesting contrast thereby. Too, a strong pure color note is often so necessary to give a room an accent, and there is no better way to secure it than to use a lamp-bowl in some strong pure color with a glazed or semi-glazed surface. The usual error is not having them of sufficient bulk to be in proportion to the shade and other furnishings of the room. When metal lamp bases are used, it is consistent to make them slender, but the pottery should be round and bulging with the curve giving a counter swing to the line of the shade. It required a great deal of judgment to use a decorated lamp bowl as a base combined with a shade, since usually the shade with its trimmings has sufficient interest without a decorative pattern on the base. When bowls or vases are to be used as ornaments, then the decoration can be elaborated according to the simplicity of the background.

"I always feel that pottery for interior decoration can be roughly divided into two large divisions. First the classical type, of which the Wedgwood ware is an example, where its classical Greek curves and cameo ornament go so fittingly with a classical interior such as a Georgian Colonial or Louis XVI French room. There are some Roman and Pompeian forms in the recently arrived Italian wares, which make interesting spots of color in this type of room. Then there is the interior of the style of Louis XV in France and Queen Anne in England which has a flavor of romantic luxury; here the Chinese and Persian pottery blend most harmoniously. This is the beginning of the second type.

"In the early English and Spanish interiors, which are so popular with our small homes today, the peasant ware from France and Spain blends most consistently with the rough plastered walls, turnings of chair and table legs and the gaily colored upholstering.

"Majolica wall vases and jardinieres used sparingly make an interesting decorative note. The iridescent ware which depends on its graceful silhouette and subtle coloring is most effective in this type of room.

"It is very interesting to observe the reminiscence of old Roman forms in the Italian peasant ware. They seem to be vaguely remembered from

some racial impression of the past and naïvely expressed in the crude earthenware. The same is true with the Spanish peasant pottery—always just a flavor of the old Moorish. In the French peasant ware from Brittany, the pastoral scenes in their yellows and blues are really a free interpretation of what was more elaborately done for Marie Antoinette. It is natural that a people should express a certain racial flavor in the great works of their past.

"This opens up a most interesting vista of what we, as Americans, are going to develop as a racial flavor in the pottery we are making. It is pleasing to note that the Rookwood and some of the pottery from Zanesville and East Liverpool, Ohio, are really graceful in form. The Pewabic Pottery made in Detroit, Michigan, has been very carefully thought out as regards shapes, colors and glazes. The marvelous collection of Syrian shapes dated about 3000 B.C., and owned by Mr. Freer were placed at the disposal of Miss Perry when she was first working out the Pewabic destiny. Her work is more for people who understand the possibilities, limitations and ideals in pottery; it will never be commercial and popular.

"But the pottery which gives me a real emotional sensation is the Indian pottery of the Southwest. The shapes and colorings seem to come from the inner consciousness of a simple Indian and have a fundamental quality of design, which cannot be found in the more sophisticated East.

"They tell us we are developing a national architecture in the sky scrapers of the last few years. They are quite simple and fundamental in silhouette and composition. Can we not hope from this that the national flavor we give our ceramic design will eventually have this same simple fundamental quality? At present it is not a free expression like that of the foreign pottery; it is too self-conscious, too obviously made to sell.

"I have always been much against an artist decorating a piece of pottery which he has not fashioned himself. There is such an intimate relationship between the shape and decoration that it is quite fatal to divide the inspiration by having two people work—one on the shape and one on the decoration.

"The chemistry involved in the colors and textures of the glazes must be most fascinating. I have dreamed of getting old and retired and being able to take up pottery as an avocation, for I consider it one of the most fascinating of the applied arts."

For the thoughtful ceramist, there are many suggestions in Mr. Robertson's remarks. Doubtless the most important point, and one which is difficult to solve is the establishing of a type of pottery which is really beautiful in form, line, decoration and color, and which has an American flavor. That means the finest of American life and ideals must be expressed in a simple, beautiful, practical way. To do this, trained artists, knowing something of ceramic technique, must guide the art side of production.

Already, there are a few trained people in the country, but more are needed. Every ceramic school should have an art course. Even the engineers should be trained to judge whether a thing has beauty—though they may not be able to create designs. Our art schools should apply the original expressions to materials, one of which would be clay.

The potteries should send their self-trained artists to get an understanding of the principles of good design; also they should use to advantage the few who already understand both design and ceramic technique. All these suggestions introduce other problems which would have to be solved along the way. It will take time but it must be done sooner or later.

A buyer in one of the best and largest china departments in the United States told me he buys most of his stock from Europe, because the ware is more artistic and original. He added that very few of their customers like the American china with the exception of the Lenox ware. When I left his office, I requested a salesman to show me the china. Immediately, I was taken to the imported products. One table was filled with refreshment sets for bridge parties. The ware was stamped on the bottom "Made in Japan." Do the Japanese play bridge? If not, why was it made there? Upon request to see the American ware, it was explained that they *do* carry it, but of course it is not as beautiful as the foreign ware. With the exception of the Lenox, it was all in a small back room. As we entered, the salesman picked up a plate saying, "This is the most attractive pattern, it is a copy of an Old English."

American copies of foreign art lose the beauty, because the inspiration is gone. We *must* express *ourselves* in an artistic way if we are to compete. Naturally, American expression if beautifully produced would fit our homes and tastes better than foreign production. We must meet the situation, for the public is being taught to choose the most beautiful. The need will be the greater when the "American style" of home develops as it has already started to do.

Art Institute of Chicago
Chicago, Ill.

AMERICAN CERAMICS FOR INTERIOR DECORATING

The Silver Lining in the Cloud

By Paul E. Cox

There was once a lodge known as the Order of Humility. A person worthy of being an active member of this lodge had to have the quality of humility developed to the point where he was perfectly comfortable in the lodge room when seated on the bare floor, since chairs and pride went hand in hand. Americans are in danger of active memberships in this

uncomfortable Order if they fail to see the fine things done by Americans as well as the poor things, and particularly is this true in ceramic products.

Certainly we make our share and more, of trashy ceramic products and it is good that we are to be lifted out of this habit of ours. But Europe, and likewise China and Japan, are not more free from fault than are we.

A cultured man traveling in Italy was pleased by the Neapolitan street songs. Most people who live abroad are interested in the songs played and sung on the streets of European cities. He brought back a collection of these songs and a very competent musician played them over for him and his friends. They had the plaintive quality of street songs the western world over, and a listener remarked that they were so much better than American songs of the street. The musician remarked that nevertheless they were just Italian trash and of brief interest just as are our own. There is likewise foreign trash in ceramic products just as there is trash in domestic products.

On the whole it is probable that we do better in ceramic wares than we do as musicians in the final balance sheet of the nations.

Of course there is no defense possible for most of the white table ware produced in America. But neither is there any defense possible for the paper plates, spoons and forks, used at an American picnic lunch. There is not an artistic thing about paper table service. There are markets, however, for both types of table services because they are cheap, do the work for a time proportionate to the cost and so serve their purposes well enough. People are careless in small purchases and most American whiteware finds its market with the small purchaser.

But two or three American manufacturers have set out seriously to supply table services that compete on a quality basis with imported wares and in those cases they have made pace right along.

As long ago as the Columbian Exposition the wares made by James Pass would stand more hard knocks than those of any competitor, the authority for this statement being Charles F. Binns, who told the writer the story of the contest twenty-seven years ago. American potters have excelled in the development of wares suited to institutional uses and the quality of decorations has been proportionate to the quality of the body and glaze in most cases.

Lenox china needs no comments.

Ceramically speaking the best "little boner of childhood" in America is that Haviland china is the most desirable white table service in the world. So long as the American housekeeper believes that the possession of a set of Haviland marks her as the person knowing what is what, we shall have no demand for better work by American potters, because now we have for Sunday and other feast days a set of Haviland and for work days a set of domestic that looks like Haviland "but is not so thin and is not translu-

cent." For breakfast in the faddy little breakfast alcove we have the set with blue birds on it that we got at the dime store.

Anyhow most folks have quit buying dinner services, because they hop into the flivver as soon as evening comes, taking their friends along and entertaining them away from home. Some of the old pride in household fittings is being expended on the family car, and the cheap but carelessly made dinner service is the one that is bought.

The restaurant man, however, has to buy more carefully for this same reason, and as a consequence we have in America the best hotel ware that is manufactured. Those American universities that offer courses in household economics need not have pangs of conscience when the teachers endorse American made hotel wares for home and institutional use.

American floor and wall tile plants have not dropped behind in the race with the foreigner. It is true that there is a softness in color and line in the decorated tin-enameled tiles of Europe that we need to learn to appreciate and to imitate but likewise there is another sort of softness in the body of those tiles that we know better than to permit in our own better manufactures. The employment of a few artists who possess the tact to coöperate and to work in industrial fashion with our very capable engineers will put us far in the lead in this important ceramic field. The work of Rufus B. Keeler reported in a beautifully illustrated article in the July number of this *Bulletin* on the Use of Clay Products in Modern Homes shows what can be done when the ceramic scientist and artist coöperate.

In terra cotta we have done well, but we can do better when we follow the lead of the tile makers and produce our wares with a dense body. This would be of the "grés" type, in the method demonstrated by Sèvres at least three decades ago. There are, however, buff burning clays in many places that will produce dense products at the low temperatures used in American terra cotta and the warm palette asked for by the architects could be had, coupled with low absorption values. There are architects who believe that they, themselves, are to blame for the failures, artistically, in the use of terra cotta, since the terra cotta manufacturer works so largely on specifications furnished by the architects.

This brings us to the field in ceramics in which Americans excel.

It is not fair to name these little enterprises because the list is so likely to be far from complete. Nevertheless the point can best be made by naming a list of small concerns making wares of such perfection that no American need be ashamed to possess them and to place them in company with ceramic products of any country and of any time.

Rookwood, Newcomb, Van Briggle in the days of the Van Briggles, Volkmar, Grueby, Overbeck, Pewabic, Cowan, Marblehead, Walrath, Binns, Mrs. Frederick Rhead, Rhead, Thomas and Bragdon, Joseph F. Meyer, George Ohr, Maude Robinson, Mrs. Bentley Nicholson, Stull,

and many others who have worked or are working, make a list of firms and individuals that differ markedly from a similar list of European potters, because for the most part the European potter is a man of traditions while these people took tradition and improved, because most of the above named persons are workers for the love of the business and are, for the most part, college bred.

There is no thought that the list is complete enough to be fair but it is complete enough to make the points.

Rookwood can furnish any color wanted by any decorator and decoration of any quality and of most periods. The Rookwood staff is as well equipped intellectually as is any staff of any pottery abroad.

Newcomb School of Art has been the most faithful producer of individually designed pottery, I think, that ceramic history can show. That is, there are no duplications of the designs.

Since the Van Briggles were Rookwood decorators, their story is simply that of the Rookwood but they did not have the facilities for technical perfection. Volkmar serves us best to show us what type of man we ought to bow to in improving our more commercial types of wares. Any collector of ceramic wares ought to want his products. Those interested in glaze textures can find in Grueby as interesting things as they can find abroad, and I believe that the Grueby genius has been now transferred to that little pottery at Keene, New Hampshire. The Overbeck sisters are modest in their output but the wares they offer are honestly and faithfully made and their skilful use of both body and glaze in securing of color effects makes their ware as interesting certainly as a foreign product. The Pewabic tiles did not fail to interest architects for ecclesiastical decoration where European made tiles could have as well been used so far as cost was concerned. Cowan makes some lustered white wares that do carry an individual note in this rather hackneyed treatment, so that I think that those who enjoy lustered wares like those of the Ruskin Pottery will find Cowan not far behind at all. Marblehead has for twenty-five years produced a line not to be excelled by any importation and Arthur Baggs has shown some things in lively color that ought to please any decorating firm in the land, these pieces being unsophisticated. Walrath made a good many pieces of merit and had the temperament to produce a line comparable with the best that comes from abroad and a fondness for working alone so that from him we had a sort of college bred peasant pottery. His early death robbed us of much. Professor Binns has fathered more studio potteries than any other American and it has been a splendid thing for us that he left England to become an American citizen and to make his American stoneware. Most surely any decorating firm could find what they want for large colored bits in their scheme of decoration from the line he has produced, and Professor Binns has not reserved this field to himself

if any manufacturer pleases to take it on. Mrs. Frederick Rhead working with Mr. Rhead produced pâte-sur-pâte of such excellence that we know we do not absolutely have to import that type of ware if a more commercially inclined person should want to produce this in America. Rhead has produced many fine vases of all sorts, of exactly the type wanted by house decorators. Thomas and Bragdon have worked on small bowls and tiles in colors suitable for the house decorator. Meyer, the Newcomb potter, has made pottery under the plan of the Italian luster workers of such merit that a gold medal came to him from the St. Louis Exposition. He has not made this ware for sale because he is a simple craftsman, and not a business man. George Ohr, of Biloxi, made many pieces as interesting as can be had from abroad but his eccentricities robbed him of the fame he craved. Some considerable portion of his wares are still to be bought from his widow and a discriminating collector could pick up some choice bits, I think. His work was certainly as interesting as is the work of any European peasant. Miss Robinson has been making wares of interest to New Yorkers, and for people who can buy abroad if they prefer, while Mrs. Nicholson chose the field of the majolica makers and produced the low temperature copper reds. R. T. Stull made the crystalline glazes almost as early as they were produced in Europe, and some of Stull's crystals are better than any I saw at Sèvres in their museum collection.

Now the point to all this is that we are really independent of foreign ceramic goods if we want to be and we need to know that we are. Unfortunately our schools of art educate their students away from work in the factories so that in America we have few good designers interested in any way in ceramic wares in the factories. We have too many persons standing off and preaching at us while we need the same persons in the plants with the sleeves rolled up and doing their missionary work for just plain pelf. The engineers from the colleges have done their work well because they got into the plants and into the jobs.

The city of Paris has just as rich a market for trashy French pottery as has the city of Chicago for trashy American pottery, and for similar reasons which are reasons very human in character, folks over there buy cheap dishes, usually less sanitary in use than our own because less well made.

We need the artists in our potteries as well as all our industries and the ceramic engineer must learn to tolerate the artist and the artist must learn to tolerate the engineer. But we need them to make our own wares better and not because we are more rotten than our friends across the Atlantic. We need to hire American artists and to make our wares in American ways and our house decorators need to think out schemes of decoration that are American and to use our very excellent American decorative pottery. I spent many days in the Sèvres plant and learned that several of our American art potteries are more careful even than they are at Sèvres

and that many of our designers are equally well trained and equally skilful. I had to live in France to learn how well we do our ceramic work in our smaller factories and studio concerns.

AN IDEAL ENDEAVOR IN SCIENCE AND ART

By Karl Langenbeck.

The vision of Professor Orton in enlisting the few who had already had systematic training in ceramics, and those who sought knowledge to supplement their practical experience, has borne generous fruit in the amazing development of our Society. We have a sodality for mutual support and an ideal of generous helpfulness to advance our profession second to none. Have we beaten an open road of endeavor, in solving practical problems for the benefit of all, that is sufficiently satisfying to be exclusively followed for the next twenty-five years?

A profession is merely a livelihood. Numberless pressures force us, day by day, to leave it at that. Can we remain satisfied with the usufruct and incidental search for immediate practical solutions, however generously shared?

A Plea for Fundamental Science Researches

The tools of our professional thinking, practical experimentation and industrial applications are derived from chemistry and mechanics. We surely owe these sciences the only possible return that can be made, namely, extension of their boundaries along the lines of our specialty, the fabrication of silicate wares.

But we are pushed by practical problems. We must satisfy commercial associates, whose stock suspicion is that we may be spending time on things that do not pay. A set determination to spend some of our time, thought and work on purely scientific questions, will involve moral courage in demonstrating the practical value of purely scientific researches.

Is it not well to prove to ourselves that we will not slip down the easy path of becoming wage slaves, toward which we are insidiously headed?

Chemistry, as science, is an organization of laws of the things unseen, which underlie the phenomenal. Electrons, atoms, molecules, compelling creations of the mind, are the substance of its systems. They are invisible noumena, more concrete than the shifting and confusing phenomena, which we observe, and they cause.

The chemistry of the fluid or plastic silicate solids is barely known. For to be chemistry in any real sense the degree must be measured and shown to which the laws of stoichiometry, of surface attraction, mass action and osmosis separately determine the observed phenomena of colloids. Only then can it function as science.

We can all weigh, measure and calculate. We can all determine to be

"hod carriers of science," as Huxley said, and gather the brick for this structure to be reared. What we must severally determine is to resist the constant pressure of the immediate and practical to the extent of reserving some time for thought and measurements on clear cut lines of chemical and physical laws.

We should think and search in a spirit of complete detachment and without utilitarian aim. Each one of us, so minded, can contribute something. In doing this let us cling confidently to the belief that some one of our number with breadth of vision and penetration of discernment for the essential will build from such data this branch of chemical science to the general honor of our SOCIETY and to the fruitful use of the world.

Is it too much to believe that our SOCIETY can bring forth a van't Hoff, an Arrhenius or a Willard Gibbs? The personally little rewarded labor of a "hod carrier of science" will appeal only to those of us with a strong scientific bent.

A Plea for Art Researches

To the buying public the largest proportion of ceramic products appeal for their attractiveness and cultural quality. If my appeal for reserving some of our time and interest from purely professional endeavor has any weight, they can be exercised in seriously studying our wares and learning from artists, what constitutes good taste and what are the ear marks of the shoddy.

Remember that pottery, the first of the arts employing fire, became a mode of expression and the vehicle of taste for primitive man almost as soon as it was a practical craft. With glass it was no less the case.

To the ethnologist the ceramic products of a people are among the most important data of its culture. So also from the dishes and bric-a-brac in the house of strangers, the ladies of your family arrive at a shrewd opinion, as the colored servants put it, "da's of de quality."

The women are the buyers of every family, and make also the main body of the students, amateur practitioners and patrons of the decorative arts. On the other hand, in painting, architecture, landscape gardening and the larger decorative work, appreciation and interest are no longer so one-sided, and women themselves have improved in taste with the growth of masculine interest in these.

These facts being demonstrable, can we afford to give but tolerant, casual attention to questions of original, artistic creation, which is the larger part of ceramics to its buyers?

There is an excuse for this undeniably cavalier attitude in a profession based on science. It feels that its work is worth while because it is founded in eternal verities and decorative art, though it seems to many of us a matter of fads, a thing of personal preferences, which suits one if it does not suit another. A sympathetic interest and some study will reveal to

us that this is not true. Running through all modes of human expression in art, as in literature, there are fundamental criteria of quality, of taste, as certain as the laws of science. They are felt in every representative example of the decorative art of every epoch. The distinction from scientific laws is that they are qualitative. Each generation varies the emphasis and proportion according to its need and habits, because they are laws of the human species and not of indifferent nature.

The opportunity for this broadening of interest and education is already laid through the able work of Mr. Rhead, Miss Sheerer, Prof. Cox, and others within our SOCIETY and by the experimental work and teaching of Professor Binns. I can only emphasize the importance of their work and point out an ideal into which it should culminate.

A ceramic society, however successful professionally, will be a barren affair in the eyes of consumers if it does not evolve men capable of selecting and directing artists and adapting technical facilities to produce glass and pottery wares new in conception and worthy of the taste of the time. As long as designing in our shops is left to trade craftsman, moldmakers, decalcomania lithographers, however clever, it will always remain imitative.

What is needed is a gamble in fresh blood. You are the men to do it, but you have to train yourselves for it. Josiah Wedgwood achieved what he did by engaging the sculptor John Flaxman, a thing unheard of in English potteries. Ag amble like this pays and I wish to remind you that the American pottery and glass which have achieved reputation did so on this basis.

In hoping that many of you will strive for command in this direction, the reputation of our SOCIETY will ultimately stand out, I am sure, in bringing forth a Della Robbia, a Wedgwood or a Theodore Deck.

AMERICAN CERAMICS

BY ROSS C. PURDY

Much has been said and written lately about the relative merits of ceramic ware produced on this continent and in Europe. Broad statements have been phrased but actually intended only for limited types of ceramic ware. These statements have been given not in a manner mean but with the purpose of getting to the facts.

The citations may show a lack of information; they may disclose prejudices on part of the buyers and they may appear to overlook commercial considerations but no inference should be drawn regarding the writers' opinions of the ability of the American ceramist to produce. The ability and resourcefulness of the American ceramists have not been questioned.

Certainly American manufacturers of ceramic ware are fully aware of the market demands, the foreign competition and the commercial factors

involved, and the manufacturers are so managing their plants as to produce the highest quality of ware and the best of ceramic art compatible with the economics as they appear to be of the prevailing trade and labor situation.

There would be decadence if manufacturers did not frankly study the problems of competition in quality and artistic merit as well as those of commerce. A bald statement of facts will be beneficial though not always pleasant, and certainly not always understood. We ask that the statements made be accepted as honest efforts to present those phases of the situation which appear most prominent to the writers. No one has attempted to sum up the case for all the evidence is not before them. No one is attempting to placard nor to give alibi; they are simply giving testimony because they have a deep and sincere interest in American ceramics.

Broad statements covering the relative merits of all American ceramic ware cannot be made. Although the science (silicate chemistry) of ceramic compounding, and the technology (applied physics and chemistry) of ceramic fabrication are basically the same, ceramic products differ widely in kind, use and properties. Ceramic products include those made with clay, glass and vitreous enamels. In general all of them are made by fusing minerals and metal oxides to form silicates, each sort or variety of ware being made to have different serviceable, protective or decorative properties. Any statement to be of value or in truth regarding relative merits of ceramic products will have to be definitely limited to a given type, variety and purpose.

Glass containers will differ in quality of glass, perfection in molding and in design according to the need in each of these respects to satisfy service and esthetic demands. So it is with china, majolica, terra cotta, brick and all other ceramic ware. For that matter, this is also true in all sorts of utility and decorative products. Quality, form and decoration are dictated most largely by their use and by the purchasers' tastes than by the producers.

It is true that the producer can create a product in anticipation of a demand. Purchasers can be trained to want a new article, a better grade or different decorative effect. Why is Toronto a city of brick dwellings, Worcester of three deck frames and Baltimore of batteries of two rooms to a floor?

In art and in utility ceramic ware the producers are ever watchful of the trend in trade demands. Practically nothing worthwhile of foreign make is on the market which cannot here be produced on order. If this continent is not producing ceramic ware of all sorts that are at least equal in all respects to those imported a survey will show the reason to be commercial rather than a lack in ability or resources.

In many lines American ceramic ware are superior in quality and craftsmanship. No utilitarian porcelains are superior to those produced here. American glass and vitreous enameled products are not excelled in any respect, and America is not behind in methods of and equipment for their production. In ceramic construction ware and in refractories, the American products are inferior to none.

The number of art potteries producing original decorative effects is increasing as is the number of tableware plants producing high-grade china, high-grade from the standpoint of quality and art.

Cost of production is a large factor in the case; reflected as it is in the cost to the ultimate purchaser. A great deal of imported ceramic ware is sold below what would be its production cost in America. The purchasers are not impelled by patriotism to buy exclusively "made in America" ware; they are intent on getting the most for their money.

Then too, the products of each country are bound to be distinctive especially in decorative effects, the ware of different nations differing more widely than do the products of different factories in the same country. To secure the largest possible variety in decorative ware, one would make his selection from all countries; but this is not an adequate explanation for a given store not showing American made goods equal in variety, as pleasing in design, color and texture as is produced in any country.

Too much dependence has been placed on tariff as means of maintaining the home trade. There has been too little creative and progressive planning to develop and meet the demand for distinctively American products. There is no reason why American table service should not be the standard of perfection in the minds of American housewives. American potters can, they have and they now are producing dinner ware equal in all respects to any produced elsewhere but a great deal of such ware purchased in this country is not American make. This situation will change as the hotels and restaurants purchase on specifications rather than according to the prejudices of their chefs.

American ceramic ware will have their rightful share of domestic trade when the manufacturers, the schools and the research bureaus are united in determining the quality and character of product required and the methods whereby they can most economically be produced. The science schools will have to stress the essentials in products, and in economical production, and the art schools will have to stress creation of form and decoration. The schools and the research institutes have a responsible share in making strong America's position in the ceramic market, and the purchasing public must be informed. The problem of keeping American ceramics in front ranks is not altogether up to the managers of ceramic factories. There should be a close collaboration of the industrialists, engineers, scientists and artists.

BIBLIOGRAPHY OF CLAY DEPOSITS[1]

By H. Ries

Foreword

In the preparation of this *Bibliography of Clay Deposits* all available sources of information have been consulted, and it is believed to be fairly complete. Many references have also been kindly supplied by the various State Geologists as well as the Directors of foreign geological surveys.

The data have been arranged geographically by continents and countries, under which latter they are arranged alphabetically by authors.

Since fullers' earth, laterite and bauxite are essentially clayey materials, and are usually associated with true clays, they have been included in the references.

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[1] Dr. Ries, a member of the Geological Survey Committee, presents this *Bibliography* as a preliminary to further work by the Committee. Lately there has been considerable interest in classification of clays on basis of similarity in industrial availability. A bibliography of this sort is the necessary first step in such a survey. The compiling of such a bibliography involves wide reading and tedious labor. We know we can bespeak a very general appreciation of Dr. Ries' generosity in making available this *Bibliography*.

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NORTH AMERICA—UNITED STATES

Alabama

Brewer, W. M.—The Warwhoop Bauxite Bank, Alabama. *Eng. Min. Jour.*, **55,** 461 (1893).

Butts, Charles—Clays of the Birmingham District, Alabama. U. S. Geol. Surv., *Bull.* **315,** 291–5 (1907).

Chatard, T. M.—Analysis of Kaolin from Greenville, Ala. U. S. Geol. Surv., *Bull.* **78,** 120 (1891).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 357 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 282, 292 (1897).

Clark, G. H.—Mica Deposits of Alabama. Ala. Geol. Surv., *Bull.* **24,** 115 pp. (1921).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv. *Bull.* **522,** 72–7 (1913).

Gibson, A. M.—Report on Murphrees Valley. Halloysite. Ala. Geol. Surv., p. 121 (1893).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Part III,* p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Am. Inst. Min. Eng.*, **24,** 243–54 (1894).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 507 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 611, 612 (1894).

Hillebrand, W. T.—Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228,** 357 (1904).

Judd, E. K.—The Bauxite Industry of the South. *Eng. Min. Jour.*, **83,** 574–75 (1907).

McCalley, H.—Alabama Bauxite. *Proc. Ala. Ind. and Sci. Soc.*, **2,** 20–32 (1892).

McCalley, H.—Report on the Valley Regions of Alabama. Paleozoic Strata. Part I. On the Tennessee Valley Region. *Geol. Surv. of Ala., 1896,* pp. 68, 105, 180 (1896).

McCalley, H.—Report on the Valley Regions of Alabama. Part II. On the Coosa Valley Region. *Geol. Surv. of Ala., 1897,* pp. 84–6, 177–83 (1897).

Mallet, J. W.—Analyses of White Porcelain Clay from Jacksonville and Randolph County, Ala. *Am. Jour. Sci.*, 2nd ser., **23,** 183.

Mell, P. H., Jr.—The Southern Soapstones, Kaolin and Fireclays and Their Uses. *Trans. Amer. Inst. Min. Engrs.*, **10,** 318 (1882).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Part V (cont.), 1896–97,* pp. 1127–9 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 67–78 (1903).

Ries, H.—Preliminary Report on the Clays of Alabama. Geol. Surv. of Ala., *Bull.* **6,** 220 pp. (1900).

Ries, H., Bayley, W. S., and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 82, 128–31, 204–5, 222–3 (1921).

Smith, E. A.—The Cement Resources of Ala. Clays and Analyses. Geol. Surv. of Ala., *Bull.* **8,** 66–75.

Smith, E. A.—The Clay Resources of Alabama and the Industries Dependent upon Them. *Eng. Min Jour.*, **66,** 369 (1898).

Smith, E. A.—The Clays of Alabama. *Extracts, Proceedings Alabama Industrial and Scien. Soc.*, **2,** 33–42 (1892). (Abs. in *Eng. Min. Jour.*, Aug. 22, p. 368 (1893).)

Smith, E. A.—The Clays and Ochers of Alabama. *Eng. Min. Jour.*, **85,** 1088 (1908).

Smith, E. A.—Geological relations of the Clays of Alabama. Ala. Geol. Surv., *Bull.* **6,** 69–113 (1900).

Smith, E. A.—The Portland Cement Materials of Central and Southern Alabama (Clay Analyses.) 58th Cong., 1st Sess., *Sen. Doc.*, **19,** 12–23 (1903).

Smith, E. A.—Sketch of the Geology of Alabama (Porcelain Clays and Bauxites, pp. 5, 23, 24), n. p. (1892).

Smith, E. A.—Sketch of the Mineral Resources of Alabama (Kaolins, Porcelain Clays and Bauxite, pp. 6–7). Published by direction of Issac F. Culver, *Com. J. Agric.* (no date nor place; probably 1897).

Smith, E. A. and McCalley, H.—Index to the Mineral Resources of Alabama (Clays, pp. 33–42) (1904).

Arizona

Allen, E. T.—Analyses of Salt River Valley, Arizona Clays. U. S. Geol. Surv., *Bull.* **228,** 368 (1904).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 90 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* 526 (1892).

Ransome, F. L.—Bisbee Folio. U. S. Geol. Atlas Fol., No. 112, p. 17 (1904).

Arkansas

Berger, W. F. B.—Bauxite in Arkansas. *Eng. Min. Jour.*, **77,** 606–7 (1904).

Branner, J. C.—Bauxite in Arkansas. *Amer. Geologist*, March, 1891. (Abs. in *Eng. Min. Jour.*, Jan. 24, p. 114 (1891); *Trans. Federated Inst. Min. Eng.*, **3,** 1057 (1891–92); *Jour. Iron and Steel Inst.*, **1,** 275 (1891).)

Branner, J. C.—Brick Clays of Washington County, Ark. Geol. Surv. Arkansas, *Ann. Rept.*, **4** (1888); Geology of Washington County, p. 121 (1891).

Branner, J. C.—Preliminary Report to the Governor of Arkansas on Bauxite and Kaolin. *Arkansas Gazette*, Jan. 8 (1891). (Same reprinted in 3rd Biennial Rept. Bur. Mines, *Manufactures and Agric. for 1893–94*, pp. 119–26, Little Rock (n. d.). Also in 4th Biennial Rept. of same for 1895–1896, pp. 105–12.)

Branner, J. C.—The Phosphate Deposits of Arkansas. (Analyses of Clay Shales, pp. 581.) *Trans. Am. Inst. Min. Engrs.*, **26,** 580 (1896).

Branner, J. C.—The Bauxite Deposits of Arkansas. Contains Bibliography of Bauxite. *Jour. Geol.*, **5,** 263–89 (1897). (Abs. in *Science*, April 30, p. 702 (1897). Analysis in Groth's *Zeits. f. Krystallog. u. Min.* **31,** 298.)

Branner, J. C.—The Cement Materials of Southwest Arkansas. *Trans. Amer. Inst. Min. Engrs.*, **27,** 42–67 (1897).

Branner, J. C.—The Clays of Arkansas. U. S. Geol. Surv., *Bull.* **351.** (Abs. in *Eng. Min. Jour.*, **86,** 1219 (1908). Abs. in *Jour. Iron and Steel Inst.*, **79** [1], 516 (1909).)

Call, R. E.—The Geology of Crowleys' Ridge. (Clays, pp. 86, 108, 138–40; Analyses, pp. 85, 87, 89, 107, 112, 138–39.) Geol. Surv. of Arkansas, *Annual Rept* (1891).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 295, 296 (1897).

Eakins, L. G.—Partial Analysis of Kaolin from Garland County, Ark. U. S. Geol. Surv., *Bull.* **78,** 120 (1891).

Eckel, E. C.—Clays of Garland County, Ark. U. S. Geol. Surv., *Bull.* **285,** 407–10 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 113–5 (1913).

Fermor, L. L.—Discussion of paper by Wysor, Aluminum Hydrates in the Arkansas Bauxite Deposits. *Econ. Geol.*, **11**, 686–90 (1916).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **9**, 241–2 (1903).

Fitzhugh, G. D.—The Portland Cement Materials of Southwestern Arkansas. *Trans. Eng. Assoc. South, for 1904*, **15**, 33–42 (1905). (Abs. *Geol. Centralb.*, **7**, 589 (1905–1906).)

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. III*, p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Am. Inst. Min. Eng.*, **24**, 243–54 (1894).

Hayes, C. W.—Bauxite Deposits of Arkansas. *Mining and Metallurgy*, **24**, 328–29 (1901). (Abs. *Min. Ind.*, **11** (1903).)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, 516–8 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, 612 (1894).

Mead, W. J.—Occurrence and Origin of the Bauxite Deposits of Arkansas. *Econ. Geol.*, **10**, 28–54 (1915).

Parker, E. W.—Arkansas Bauxite Deposits. *Mines and Minerals*, **22**, 327–28 (1900).

Purdue, A. H.—Possibilities of the Clay Industry of Arkansas. *Ark. Brickmakers Assoc.* (1910).

Ries, H. and Bayley, W. S.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 120–21, 255–9.

Siebenthal, C. E.—The Geology of Dallas County, Arkansas. Ark. Geol. Surv., *Ann. Rept., Pt. 2, 1891*, 279–318 (1894).

Simonds, F. W. and Hopkins, T. C.—The Geology of Benton County. Geol. Surv. of Ark., *Annual Rept., Vol. II, 1891*, p. 63 (1894).

Taff, J. A.—Chalks of Southwestern Arkansas. (Clays and Shales, pp. 737–40.) U. S. Geol. Surv., *22nd Annual Report, Pt. III, 1902.*

Wysor, D. C.—Aluminum Hydrates in the Arkansas Bauxite Deposits. *Econ. Geol.*, **9**, 42–50 (1916).

Wysor, D. C.—Diaspore Clay of Arkansas and Missouri. *Jour. Amer. Ceram. Soc.*, **6**, 501–9 (1923).

California

Anon.—The Clay Bed of Central California. *The Clay Worker*, **79**, 667 (1923).

Anon.—The Structural and Industrial Materials of California. Calif. State Mining Bureau, *Bull.* **38**, 190–259, 273–5 (1906).

Aubury, L. E.—The Structural and Industrial Materials of California. Calif. State Min. Bur., *Bull.* **38**, 13–378 (1906).

Boalich, E. S. and Others.—The Clay Industry in California. California State Min. Bur., *Prelim. Rept.*, No. **7**, pp. 108 (1920).

Burchfiel, B. M.—Refractory Clays of the Alberhill, California, Deposits. *Jour. Amer. Ceram. Soc.*, **6**, 1167–75 (1923).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 370 (1904).

Chatard, T. M.—Analyses of Two Clays from Shore of Owen's Lake, Calif. U. S. Geol. Surv., *Bull.* **55**, 89 (1889).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 285, 286, 301 (1897).

Crawford, J. J.—Structural Materials: Clay, Bricks, Pottery, etc. *13th Rept. Cal. State Mineralogist*, pp. 612–20 (1896).

Eckel, E. C.—Cement Materials and

Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 121 (1913).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **11,** 241–2 (1903).

Hanks, H. G.—Clay. *Fourth Annual Rept. Calif. State Minerologist,* pp. 139–47 (1884).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* pp. 526–8 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 613, 614 (1894).

Irelan, W., Jr.—Clay in Amador County. *Eighth Ann. Report Calif. State Mineralogist,* pp. 108, 109 (1888).

Johnston, W. D.—Clays. *9th Ann. Rept. Calif. State Mineralogist,* pp. 287–308 (1890).

Koenig, G. H.—Bentonite. *Sixth Ann. Rept. Calif. State Mineralogist* [1], 132 (1886).

Normile.—China Clay in California. *Brick,* **62,** 979 (1923).

Ries, H.—The Clay-Working Industry of the Pacific Coast. *Mines and Minerals,* **20,** 487–8 (1900).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97,* p. 1130 (1897).

Ries, H., Bayley, W. S. and Others.—High-grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** p. 126.

Russell, J. C.—Quaternary History of Mono Valley, Calif. Analyses of Lacustral Clays, p. 307. U. S. Geol. Surv., *8th Ann. Rept., Pt. I, 1886–87,* pp. 261–394 (1889).

Watts, W. L.—Coal and Clays in Amador County. *11th Ann. Rept. Calif. State Mineralogist,* pp. 146–9 (1893).

Watts, W. L.—Placer County Clay Analyses. *11th Ann. Rept. Calif. State Mineralogist,* pp. 319–22 (1893).

Colorado

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.*, **9,** 296–8 (1900).

Bailar, J. C.—The Nonmetallic Minerals of Colorado. Colo. School of Mines, *Bien. Rept.*, pp. 46–54 (1908), pp. 35–40 (1910).

Butler, G. M.—Clays of Eastern Colorado. Colo. Geol. Surv., *Bull.* **8** (1915).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 284, 297–9 (1897).

Cross, W. and Hillebrand, W. F.—Mineralogy of the Rocky Mountains. U. S. Geol. Surv., *Bull.* **20,** 97 (1885).

Darton, N. H.—Preliminary Report of the Geology and Underground Resources of the Central Great Plains. (Fire Clay from Golden, Colo., in the analyses, p. 397.) U. S. Geol. Surv., *Prof. Paper* **32** (1905).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.),* pp. 1353–54 (1897).

Eakin, L. G.—Kaolin from the Waterfall Mine, Gunnison County, Colo. U. S. Geol. Surv., *Bull.* **60,** 136 (1890).

Eldridge, Geo. H.—The Clays of the Denver Basin (with Analyses of Fire Clays). U. S. Geol. Surv., *Monograph* **27,** 387–92 (1896).

Fenneman, N. M.—Geology of Boulder District, Colo. U. S. Geol. Surv., *Bull.* **265,** 72 (1905).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **11,** 241–2 (1903).

Geijsbeek, S.—The Colorado Clay Deposits. *The Clayworker,* **36,** 424–6 (1901).

Geijsbeek, S.—Whiteware Possibilities of Colorado Raw Materials. *Trans. Amer. Ceram. Soc.*, **7,** 98 (1906).

Hill, R. T.—Clay Materials of the United States U. S. Geol. Surv., *Mineral, Resources of the U. S., 1891,* p. 524 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* p. 737 (1893).

Hillebrand, W. T.—Analyses of Rocks,

1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 366 (1904).

Hills, R. C.—Kaolinite from Red Mountain, Colorado. *Am. Jour. Sci.*, 3rd Ser., **27,** 472 (1884).

Lakes, A.—The Undeveloped Resources of Colorado. *Stone,* **14** (4), 359, 362–3 (1897).

Lakes, A.—Gypsum and Clay in Colorado. *Mines and Minerals,* **20,** Dec. (1899).

Larsen, E. S. and Wherry, E. T.—Halloysite from Colorado. *Jour. Wash. Acad. Sci.*, **7,** 178 (1917).

Larsen, E. S. and Wherry, E. T.—Leverrierite from Colorado. *Jour. Wash. Acad. Sci.*, **7,** 208–17 (1917).

Milch, L.—Über den Kaolinit von der National Belle Mine bei Silverton, Colorado. *Centralbl. f. Min.*, 1908.

Ohly, J.—The Occurrence of Bauxite in Colorado and Wyoming, and Its Utilization (1st Part). *Min. Reporter,* Sept. 12 (1901).

Reusch, H.—Krystallisirter Kaolin von Denver in Colorado. *Neues Jahrb. f. Min. Geol. u. Pal.*, **2,** 70–2 (1887). (Abs., *Bull. Soc. Min. de France,* **9,** 281–2.)

Richardson, G. B.—Clay near Calhan, El Paso County, Colo. U. S. Geol. Surv., *Bull.* **470,** 293–6 (1911).

Ries, H.—The Clay Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (Cont.), 1896–97,* pp. 1131–8 (1897).

Ries, H.—The Clays and Clay Working Industry of Colorado. *Trans. Amer. Inst. Min. Eng.*, **27,** 336–40 (1897).

Shaler, M. K. and Gardner, J. H.—Clay Deposits of the Western Part of the Durango-Gallup Coal Field of Colorado and New Mexico. U. S. Geol. Surv., *Bull.* **315,** 296–302 (1907).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 364–5 (1904).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 366 (1904).

Connecticut

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150,** 214–23(1900). (Abs. in *Rev. Amer. Chem. Research,* **7,** 67–8.)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Ledoux, A. R.—A Novel Method of Mining Kaolin. *Trans. Amer. Inst. Min. Eng.*, **37,** 319 (1907).

Loughlin, G. F. The Clays and Clay Industries of Connecticut. Conn. Geol. and Nat. Hist. Surv., *Bull.* **13** [4], 121 pp. (1905). (Abs., *Geol. Centralb.*, **8,** 34 (1906).)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 78 (1903).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 99 (1921).

District of Columbia

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 504 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 80–1 (1903).

Delaware

Booth, J. C.—Kaolin. *Memoir of the Geological Survey of the State of Delaware,* pp. 36, 37 (1841).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 288 (1897).

Hill, R. T.—Clay Materials of the United

States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503, (1892).

Matson, G. C.—Notes on the Clays of Delaware. U. S. Geol. Surv., *Bull.* **530,** 185–201 (1913).

Merrill, G. P.—Residual Clay of Feldspathic Rock. Kaolin, from Hockessin, Newcastle Co., Del. U. S. Geol. Surv., *Bull.* **150,** 382–4 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 80 (1903).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 352 (1904).

Thomas, C. H.—Mining Kaolin in Delaware. *Min. Eng. Jour.-Press.*, **115,** 933 (1923).

Florida

Anon.—Clays in Florida. *The Clayworker*, **51,** 707 (1909).

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.*, **9,** 296–98 (1900).

Bleininger, A. V.—Kaolins and Pottery Clays in the United States. *Brick and Clay Record*, **60,** 39–42 (1922).

Bussy, Ch. de.—Comité consultatif d'hygiéne publique de France. Vol. VI (1877). "Argile comestible" de Florida, dans les Annales des Mines, Ser. 7, **13,** p. 363.

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 290, 291 (1897).

Crary, J. W., Sr.—Brickmaking and Burning, pp. 3, 14, 35 (1890).

Davis, N. B.—The Plasticity of Clay and Its Relation to Mode of Origin. *Trans. Amer. Inst. Min. Eng.*, **51,** 451–81 (1916).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, pp. 1356–9 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 655, 656 (1898).

Eakins, L. G.—Analyses of Florida Clays. U. S. Geol. Surv., *Bull.* **228,** 355 (1904).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **11,** 241–2 (1903).

Gunter, H.—Mineral Production in Florida during 1918. Fla. Geol. Survey, *13th Ann. Rept.*, p. 25 (1921).

Gunter, H.—Mineral Production in Florida during 1920. Fla. Geol. Survey, *14th Ann. Rept.*, p. 26 (1922).

Hall, A. A.—Analysis of a Florida Clay. *Durham Univ. Phil. Soc.*, **4,** 228–9 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1891*, p. 507 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 614, 615 (1894).

Langenbeck, K.—The Chemistry of Pottery, pp. 99–101 (1895).

Matson, G. C.—Notes on the Clays of Florida. U. S. Geol. Survey, *Bull.* **380,** 346–57 (1909). (Abs., *Geol. Centralb.*, **14,** 131 (1910).)

Memminger, C. G.—Florida Kaolin Deposits. *Eng. Min. Jour.*, **57,** 436 (1894).

Meteyard, E.—Life of Josiah Wedgwood. Vol. I, p. 471 (1865).

Ries, H.—The Clays of Florida. U. S. Geol. Surv., *17th Annual Rept., Part III (cont.)*, p. 871 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 81–6 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1,** 446 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays in the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 289–91 (1922).

Ries, H. and Leighton, H.—History of the Clay Working Industry in the United States, pp. 78–9 (1909).

Sellards, E. H.—Mineral Industries. Fla. Geol. Surv., *1st Ann. Rept.*, pp. 31–7 (1908).

Sellards, E. H.—Fullers' Earth, Kaolin and Peat in Florida. *Eng. Min. Jour.*, **85,** 1187 (1908).

Sellards, E. H.—Mineral Industries. Fla. Geol. Surv., *2nd Ann. Rept.*, p. 242 (1909).

Sellards, E. H.—The Soils of Florida. Fla. Geol. Surv., *4th Ann. Rept.*, p. 21 (1911).

Sellards, E. H.—The Florida Phosphate Deposits. Fla. Geol. Survey, *3rd Annual Rept.*, p. 22 (1910).

Sellards, E. H.—The Relation between the Dunnellon Formation and the Alachua Clays of Florida. Fla. Geol. Survey, *6th Ann. Rept.*, p. 161 (1914).

Sellards, E. H.—Clay and Clay Products. Fla. Geol. Surv., *6th Ann. Rept.*, p. 23 (1914).

Sellards, E. H.—Mineral Industries of Florida during 1915. Fla. Geol. Survey, *8th Ann. Rept.*, p. 19 (1916).

Sellards, E. H.—Mining Industries of Florida during 1916. Fla. Geol. Surv., *9th Ann. Report*, p. 10 (1917).

Sellards, E. H.—Geology between the Ocklocknee and Aucilla Rivers in Florida. Fla. Geol. Surv., *9th Annual Rept.*, pp. 111–2 (1917).

Sellards, E. H. and Gunter, H.—Geology between the Choctawhatchee and Appalachicola Rivers in Florida. Fla. Geol. Surv., *11th Ann. Rept.*, p. 83 (1918).

Sellards, E. H.—Report on Clay Tests for Paving Brick. Fla. State Geol. Surv., *Press. Bull.* No. **7** (1915).

Sellards, E. H.—The Clays of Florida. *Jour. Amer. Ceram. Soc.*, **1,** 313–21 (1918).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 356 (1904).

Vaughan, T. W.—Fullers' Earth of Southwestern Georgia and Western Florida. U. S. Geol. Surv., *Mineral Resources for 1901*, pp. 922–34 (1902). (Abs., *Geol. Centralb.*, **4,** 144 (1904).)

Vaughan, T. W.—Fullers' Earth Deposits of Florida and Georgia. U. S. Geol. Surv., *Bull.* **213,** 392–9 (1903). (Abs., *Geol. Centralb.*, **4,** 144 (1904).)

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Amer. Inst. Min. Eng.*, **51,** 481–501 (1916).

Williams, J. L.—A View of West Florida. p. 69 (1827).

Williams, J. L.—Territory of Florida, p. 114 (1837).

Georgia

Anon.—Clays of Central Georgia. *The Clayworker*, **47,** 917 (1907).

Anon.—Clays. *Eng. and Min. Jour.*, p. 1037 (1912).

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Anon.—Georgia Kaolins to be Studied. *Chem. and Met. Eng.*, **24,** 1120 (1921).

Bleininger, A. V.—Kaolins and Pottery Clays in the United States. *Brick and Clay Rec.*, **60,** 39–42 (1922).

Bole, G. A. and Stull, R. T.—Washing Tests of Georgia Clays. *Jour. Amer. Ceram. Soc.*, **6,** 730–47 (1923).

Bole, G. A. and Stull, R. T.—Use of Sedimentary Kaolins of Georgia in Whiteware. *Jour. Amer. Ceram. Soc.*, **6,** 854–64 (1923).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 282 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, p. 1359 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Franklin Inst. Jour.*, **150,** 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7,** 67–8.)

Evans, A. W.—Bauxite Mining in Georgia. *Mines and Minerals*, June (1902).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **9,** 241–2 (1903).

Gilmore, R. B. and Fessler, A. H.—An account of an Investigation of Some Georgia Clays and Bauxites.

Jour. Amer. Ceram. Soc., **5**, *Bull.* **1**, 193–202 (1922).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 159–67 (1894).

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. III*, p. 551 (1895).

Hayes, C. W.—Geological Relations of the Southern Appalachian Bauxite Deposits. *Amer. Inst. Min. Eng.*, **24**, 243–54 (1894).

Hayes, C. W.—Clays. U. S. Geol. Surv., *Atlas Folio*, **19**, 3 (1895).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 734 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 615, 616 (1894).

Judd, E. K.—The Bauxite Industry of the South. *Eng. Min. Jour.*, **83**, 574–75 (1907).

Ladd, G. E.—Notes on the Cretaceous and Associated Clays of Middle Georgia. *Amer. Geol.*, **23**, 240–9 (1890).

Ladd, G. E.—Preliminary Report on a Part of the Clays of Georgia. Geol. Surv. of Ga., *Bull.* **6-A** (1898).

Maynard, T. P.—Kaolins and China Clay Resources of Alabama and Georgia along Central of Ga. Railway. Issued by Industrial Dept. Central of Ga. Railway (no date).

Maynard, T. P.—A Report on the Limestones and Cement Materials of North Georgia. Ga. Geol. Surv *Bull.* **27** (1912).

McCallie, S. W.—Bauxite Deposits of Southern Georgia. *Eng. Min. Jour.*, **91**, 1050 (1911).

McCallie, S. W.—A Preliminary Report on the Mineral Resources of Georgia. Ga. Geol. Surv., *Bull.* **24**, 37 pp. (1910).

Nichols, E.—An Aluminum Ore, Analysis of Bauxite from Floyd County, Ga. *Trans Amer. Inst. Min. Eng.* **16**, 905. (Abs. *Jour. Iron and Steel Institute* **2**, 228–9 (1888).)

Phalen, W. C.—The Bauxite Industry in the Southern States (Abs.). *Science*, New Ser., **39**, 400–1 (1914).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 86–93 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 82, 194–9, 224–5, 233–5, 239 (1921).

Shearer, H. K.—A Report on the Bauxite and Fullers' Earth of the Coastal Plain of Georgia. Ga. Geol. Surv., *Bull.* **31** (1917).

Spencer, J. W.—The Paleozoic Group. Clays. Ga. Geol. Surv., p. 276 (1893).

Sproat, I. E.—Refining and Utilization of Georgia Kaolins. U. S. Bureau of Mines, *Bull.* **128** (1916).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 356 (1904).

Stokes, H. N.—Analysis of Kaolin from Georgia Side of Savannah River, near Augusta. U. S. Geol. Surv., *Bull.* **78**, 120 (1891).

Stull, R. T.—Directory of Commercial Minerals in Georgia and Alabama along the Central of Georgia Railway. Issued by Industrial Department of Central of Georgia Railway (no date).

Stull, R. T. and Bole, G. A.—Refractory Possibilities of Some Georgia Clays. *Jour. Amer. Ceram. Soc.*, **6**, 663 (1923).

Vaughan, T. W.—Fullers' Earth Deposits of Florida and Georgia. U. S. Geol. Surv., *Bull.* **213**, 392–9 (1903). (Abs., *Geol. Centralb.*, **4**, 144 (1904).)

Vaughan, T. W.—Fullers' Earth of Southwestern Georgia and Western Florida. U. S. Geol. Surv., *Mineral Resources, 1901*, pp. 922–34 (1902). (Abs., *Geol. Centralb.*, **4**, 144 (1904).)

Veatch, O.—Second Report on the Clay Deposits of Georgia. Ga. Geol. Surv., *Bull.* **18,** 453 pp. (1909).

Veatch, O.—Fire Clays of Central Georgia. U. S. Geol. Surv., *Bull.* **315,** pp. 304–14 (1907). (Abs. in *Jour. Iron and Steel Inst.*, **75,** 342 (1907).)

Veatch, O.—Kaolin Mining in Georgia. *Eng. Min. Jour.*, **83,** 278 (1907).

Veatch, O.—The Kaolins of the Dry Branch Region, Georgia. *Econ. Geol.*, **3,** 109–17 (1908). (Abs., *Geol. Centralb.*, **12,** 87 (1909).)

Watkins, J. H.—Occurrence of Bauxite in Central Georgia. *Min. World,* **62,** 1073–5 (1915).

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Am. Inst. Min. Eng.*, **51,** 489, 498 (1916).

Watson, T. L.—The Georgia Bauxite Deposits; Their Chemical Constitution and Genesis. *Amer. Geol.*, **27,** 25–45 (1901). (Analyses reproduced in Groth's *Zeit. f. Krystallag. u. Min.*, **37,** 79 (1903).) (Abs., *Neues Jahrb. f. Min.*, **2,** 17 (1904). Referata.)

Watson, T. L.—A Preliminary Report on the Bauxite Deposits of Georgia. Ga. Geol. Surv., *Bull.* **11,** 169 pp. (1904).

Watson, T. L.—A Preliminary Report on the Bauxite Deposits of Georgia. Bibliography, pp. 159–69. Geol. Surv. Ga., *Bull.* **2,** 169 pp. (1904).

Idaho

Bullard, S. M.—Geology and Ore Deposits of Alturas Quadrangle. Idaho Bur. Mines and Geol., *Bull.* No. **5.**

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 526 (1892).

Skeels, F. H.—A Preliminary Report on the Clays of Idaho. Idaho Bur., Mines and Geol., *Bull.* **2,** 74 (1920).

Soper, E. K.—Fire Clays in Northern Idaho. *Jour. Amer. Ceram. Soc.*, **1,** 94–8 (1918).

Wilson, H., Bennett, A. L. and Heath, F. T.—Preliminary Report on the Residual Kaolin and Feldspar in the Pacific Northwest. *Jour. Amer. Ceram. Soc.*, **6,** 475–90 (1923).

Illinois

Alden, W. C.—U. S. Geol Surv., Geol., Atlas, *Chicago Folio,* **81,** 13 (1902).

Barrett, N. O.—Mineral Resources of Illinois in 1916. (Bibliography of Clay, pp. 38–9.) Ill. Geol. Surv., *Bull.* **30,** p. 68 (1920).

Barrett, N. O.—Mineral Resources of Illinois in 1917 and 1918, Bibliography of Clay. Ill. Geol. Surv., *Bull.* **38,** 110–11 (1922).

Barrett, N. O.—Production of Clay. Ill. Geol. Surv., *Min. Res. Ill.*, 1917–1918, pp. 84–90.

Cady, G. H.—Geology and Mineral Resources of the Hennepin and La-Salle Quadrangles. Ill. Geol. Surv., *Bull.* **30,** 52–3, 69, 110–4 (1919).

Campbell, M. R. and Leverett, F.—U. S. Geol. Surv., Geol. Atlas, *Danville Folio,* No. 67, p. 7 (1900).

Chatard, T. M.—Analyses of Two Clays from Henry County, Ill. U. S. Geol. Surv., *Bull.* **27,** 66–7 (1886).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 293 (1897).

Culver, H. E.—The Geology and Mineral Resources of the Morris Quadrangles. Ill. Geol. Surv., *Bull.* **43,** 148–9, 194–7 (1923).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** pp. 149–51 (1913).

Fuller, M. L. and Clapp, F. G.—U. S.

Geol. Surv., Geol. Atlas, *Patoka Folio*, No. **105**, p. 9 (1904).

Fuller, M. L. and Clapp, F. G.—Clays in the Patoka Quadrangle. *The Clayworker*, **41**, 706 (1904).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 510 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 735 (1893).

Hinds, H.—U. S. Geol. Surv., Geol. Atlas, *Colchester-Macomb Folio*, No. **208**, pp. 9–11 (1919).

Lines, E. F.—Pennsylvanian Fire Clays of Illinois. Ill. State Geol. Surv., *Bull.* **30**, pp. 61–73 (1917).

Parmelee, C. W.—Refractory Clays of Illinois. *Jour. Amer. Ceram. Soc.*, **5**, 685 (1922). (Abs., *Jour. Iron and Steel Inst.*, **106**, 266 (1922).)

Parmelee, C. W. and Shroyer, C. R.—Further Investigations of Illinois Fire Clays. Ill. Geol. Surv., *Bull.* **38**, 273–417 (1922).

Purdy, R. C. and DeWolf, F. W.—Results of a Preliminary Investigation of Illinois Fire Clays. Ill. Geol. Surv., *Bull.*, No. **4**, 129–75. (Abs. in *Jour. Iron and Steel Inst.*, **76**, [1], 251 (1908).)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 94–6 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 236, 284–9.

Rolfe, C. W.—Geology of Clays. Ill. Geol. Surv., *Bull.* **9**, 1–35 (1908).

Rolfe, C. W., Talbot, A. N., Purdy, R. C. and Baker, I. O.—Paving Brick Clays of Illinois. Ill. State Geol. Surv., *Bull.* **9** (1908).

Savage, T. E. and Udden, J. A.—The Geology and Mineral Resources of the Edgington and Milan Quadrangles. Ill. Geol. Surv., *Bull.* **38**, 197–8 (1922).

Savage, T. E.—Geology and Mineral Resources of the Avon and Canton Quadrangles. Ill. Geol. Surv., *Bull.* **38**, 262–3 (1922).

Savage, T. E. and Nebel, M. L.—The Geology and Mineral Resources of the LaHarpe and Good Hope Quadrangles. Ill. Geol. Surv., *Bull.* **43**, 72–5 (1923).

Shaw, E. W.—Clay Resources of the Murphysboro Quadrangle, Ill. U. S. Geol. Surv., *Bull.* **470**, 297–301 (1911).

Shaw, E. W. and Savage, T. E.—U. S. Geol. Surv., Geol. Atlas, *Murphysboro-Herrin Folio*, No. **185**, p. 15 (1912).

Shaw, E. W. and Savage, T. E.—U. S. Geol. Surv., Geol. Atlas, *Tallula-Springfield Folio*, No. **188**, p. 12 (1913).

Shaw, E. W. and Trowbridge, A. C.—U. S. Geol. Surv., Geol. Atlas, *Galena-Elizabeth Folio*, No. **200**, p. 12 (1916).

Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *New Athens and Okawville Folio*, No. **213**, p. 11 (1921).

Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *Carlyle–Centralia Folio*, No. **216**, p. 10 (1923).

Skewes, H. J.—Mineral Resources of Illinois in 1913 and 1914. Ill. Geol. Surv., *Bull.* **30**, 36–9 (1917).

St. Clair, S.—Clay Deposits near Mountain Glen, Union County, Illinois. Ill. State Geol. Surv., *Bull.* No. **36**, pp. 71–83 (1920).

Stull, R. T. and Hursh, R. K.—Tests on Clay Materials available in Illinois Clay Mines. Ill. Coal Mining Investigations., *Bull.* **18** (1917).

Udden, J. A.—Structural Materials in Illinois. Ill. Geol. Surv., *Bull.* **16**, 342–93 (1910).

Udden, J. A. and Shaw, E. W.—U. S. Geol. Surv., Geol. Atlas, *Belleville-Breese Folio*, No. **195**, p. 12 (1915).

Worthern, A. H.—Economic Geology of Illinois, **1**, 278, 453, 470, 496; **2**, 55, 303, 316; **3**, 235.

Indiana

Blatchley, W. S.—Clay in Indiana. *Eng. and Min. Jour.*, **73**, 205 (1902).

Blatchley, W. S.—A Preliminary Report on the Clays and Clay Industries of the Coal-Bearing Counties of Indiana. Dept. of Geol., Ind., *20th Annual Rept., 1895*, pp. 24–179 (1896).

Blatchley, W. S.—Natural Resources of Indiana. (Clays, pp. 18–20.) Geol. Surv. Ind., *21st Ann. Rept., 1896*, pp. 18–20.

Blatchley, W. S.—The Clays and Clay Industries of Northwestern Indiana. Geol. and Nat. Resources of Indiana. *22nd Ann. Rept., 1897*, pp. 105–53 (1898).

Blatchley, W. S.—The Natural Resources of Indiana. Clays and Kaolin. Geol. Surv. Ind., *24th Ann. Rept., 1900*, pp. 28–32.

Blatchley, W. S.—The Clays and Clay Industries of Indiana. Dept. Geol. and Nat. Resources, Ind., *29th Ann. Rept., 1904*, pp. 13–657 (1905).

Bucher, W. H.—Logan's Explanation of the Origin of Indiana's "Kaolin." *Econ. Geol.*, **16** [7], 481–92 (1921).

Collett, J.—Clays of Indiana. *11th Ann. Rept. State Geologist*, p. 21 (1882).

Collett, J.—Clays and Kaolins in Indiana. *12th Ann. Rept. State Geologist*, p. 24 (1883).

Collett, J.—Kaolin in Owen Co., Indiana. *7th Ann. Rept. State Geologist*, p. 358 (1876).

Cox, E. T.—Indianaite. *Geol. Rept. Indiana*, 1874, pp. 13–19. (Abs., *Amer. Jour. Sci.*, **10**, 3rd Series, p. 306; *Pop. Sci. Monthly*, **7**, 760 (1875).)

Cox, E. T.—Porcelain Tile, and Potters' Clays. Eighteen Analyses of Clays. *Geol. Rept. Indiana*, pp. 154–63 (1878).)

Fuller, M. L. and Clapp, F. G.—Clays in the Patoka Quadrangle. *The Clayworker*, **41**, 706 (1904).

Gorby, S. S.—The Clays of Miami County, Ind. *16th Ann. Rept. State Geologist, 1888*, pp. 176, 177 (1889).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 510 (1892).

Logan, W. N.—A Bio-Chemical Theory of the Origin of Indianaite. *Science*, New Ser., **49**, 197 (1919).

Logan, W. N.—Note on the Occurrence of Indianaite in Monroe Country, Indiana. *Indiana Acad. Sci. Proc.*, pp. 177–82 (1918).

Logan, W. N.—Kaolin of Indiana. Ind. State Dept. of Conservation, *Bull.* **6** (1920); also *Econ. Geol.*, **15**, 542 (1920).

Logan, W. N.—Report of the Division of Geology Ind. Dept. Conservation, *1st Ann. Rept.* (Reprinted from Year Book), pp. 9–39 (1920).

Logan, W. N.—Economic Geology of Indiana. Ind. Dept. Conservation, Handbook of Indiana Geology, No. **21**, p. 571 (1922).

Logan, W. N.—Indianaite of Indiana. U. S. Geol. Surv., *Bull.* **708**, 147–54 (1922).

Logan, W. N.—Refractory Clays and Shales of Indiana. *Jour. Amer. Ceram. Soc.*, **7**, 201–6 (1924).

Ries, H.—The Clayworking Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, pp. 1138, 1139 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 98–114 (1903).

Ries, H.—The Deposits of Indianaite near Huron, Lawrence County, Ind. U. S. Geol. Surv., *Bull.* **708**, 154–62 (1921).

Thompson, M.—The Clays of Indiana. *15th Ann. Rept. of State Geologist*, pp. 34–40 (1886).

Thompson, W. H.—Indiana Kaolin. *16th Ann. Rept. of State Geologist, 1888*, pp. 77–80 (1889).

Iowa

Arey, M. F.—Brick Clay of Black Hawk County. Ia. Geol. Surv., *Ann. Rept.*, **16,** 449 (1905).

Bain, H. F.—Clays of Appanoose County. Ia. Geol. Surv., *Ann. Rept.*, **5,** 434–6 (1895).

Bain, H. F.—Clays of Carroll County. Ia. Geol. Surv., *Ann. Rept.*, **9,** 101–3 (1898).

Bain, H. F.—Clays of Decatur County. Ia. Geol. Surv., *Ann. Rept.*, **8,** 300, 301 (1897).

Bain, H. F.—Clays of Guthrie County. Ia. Geol. Surv., *Ann. Rept.*, **7,** 475–9 (1896).

Bain, H. F.—Clay Industries of Keokuk County. Ia. Geol. Surv., *Ann. Rept.*, **4,** 302–4 (1894).

Bain, H. F.—Cretaceous Deposits of Sioux Valley. Ia. Geol. Surv., *Ann. Rept.*, **3,** 101–14 (1893).

Bain, H. F.—Clay Industries of Mahaska County. Ia. Geol. Surv., *Ann. Rept.*, **4,** 368–72 (1894).

Bain, H. F.—Clays of Washington County. Ia. Geol. Surv., *Ann. Rept.*, **5,** 163–6 (1895).

Bain, H. F.—Clays of Woodbury County. Ia. Geol. Surv., *Ann. Rept.*, **5,** 288–95 (1895).

Bain, H. F.—Clays of Polk County. Ia. Geol. Surv., *Ann. Rept.*, **7,** 366–405 (1896).

Bain, H. F.—Clays of Plymouth County. Ia. Geol. Surv., *Ann. Rept.*, **8,** 351–4 (1897).

Bates, C. O.—Analyses of Clays. Ia. Geol. Surv., *Ann. Rept.*, **7,** 382, 386, 389, 391 (1897).

Beecher, M. F.—An Investigation of Iowa Fire Clays. Ia. State Coll. Agric. and Mech. Arts., Eng. Expt. Sta., *Bull.* **40** (1915).

Beyer, S. W.—Clays of Boone County. Ia. Geol. Surv., *Ann. Rept.*, **5,** 222–8 (1895).

Beyer, S. W.—Clay Industries of Marshall County. Ia. Geol. Surv., *Ann. Rept.*, **7,** 252–6 (1896).

Beyer, S. W.—Clays of Story County. Ia. Geol. Surv., *Ann. Rept.*, **9,** 219–25 (1898).

Beyer, S. W.—Clays of Hardin County. Ia. Geol. Surv., *Ann. Rept.*, **10,** 291–7 (1899).

Beyer, S. W. and Young, L. E.—Geology of Monroe County, Iowa. Clays. Iowa Geol. Surv., *Ann. Rept., 1902,* **13,** 415–8 (1903).

Beyer, S. W. and Others.—Clays and Clay Industries of Iowa. Ia. Geol. Surv., *Ann. Rept.*, **14,** 35–620 (1903).

Beyer, S. W. and Williams, I. A. Technology of Clays. Analyses. Iowa 1903. Geol. Surv., *Ann. Rept.*, **14,** 29–318 (1904).

Beyer, S. W.—Analyses of Clays. Ia. Geol. Surv., *Ann. Rept.*, **17,** 79–86. 538–40 (1906).

Beyer, S. W. and Williams, I. A.—The Geology of Clays. Iowa Geol. Surv., **14,** 377–554 (1904).

Beyer, S. W., Bissell, G. W., Williams, I. A., Weems, J. B. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature,* **72,** 388–9 (1905).

Bissell, G. W., Beyer, S. W., Williams, I. A., Weems, J. B. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature,* **71,** 388–9 (1905).

Calvin, S.—Brick Clays of Buchanan County. Ia. Geol. Surv., *Ann. Rept.*, **8,** 250 (1897).

Calvin, S.—Brick and Tile of Page County. Ia. Geol. Surv., *Ann. Rept.*, **9,** 453, 454 (1900).

Calvin, S.—Cretaceous Deposits of Woodbury and Plymouth Counties. Ia. Geol. Surv., *Ann. Rept.*, **1,** 147–61 (1892).

Calvin, S.—Clays of Allamakee County. Ia. Geol. Surv., *3rd Ann. Rept.*, **4,** 94–6 (1894).

Calvin, S.—Clays of Jones County. Ia.

Geol. Surv., *Ann. Rept.*, **5**, 107–9, (1895).

Calvin, S.—Clays of Johnson County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 101–3 (1896).

Calvin, S.—Clays of Cerro Gordo County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 189–92 (1896).

Calvin, S.—Clays of Delaware County. Ia. Geol. Surv., *Ann. Rept.*, **8**, 185, 186 (1897).

Calvin, S.—Clays of Howard County. Ia. Geol. Surv., *Ann. Rept.*, **13**, 76, 77 (1902).

Calvin, S.—Clays of Chickasaw County. Ia. Geol. Surv., *Ann. Rept.*, **13**, 288 (1902).

Calvin, S.—Clays of Winneshiek County. Ia. Geol. Surv., *Ann. Rept.*, **16**, 138 (1905).

Calvin, S. and Bain, H. F.—Clays of Dubuque County. Ia. Geol. Surv., *Ann. Rept.*, **10**, 604–8 (1899).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 293 (1897).

Cook, A. N.—A New Deposit of Fullers' Earth. *Iowa Acad. Sci., Proc. for 1903*, **9**, 135–7 (1904). (Abs., *Geol. Centralb.*, **9**, 355 (1907).)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 154, 155, 160 (1913).

Emery, R.—Analyses of Iowa Clays. Geol. Surv. Iowa, by C. A. White, *Rept.*, **2**, 349–50.

Gordon, C. H.—Clays of Van Buren County. Ia. Geol. Surv., *Ann. Rept.*, **4**, 244–7 (1894).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the United States for 1891*, p. 514 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892*, p. 735 (1893).

Keyes, C. R.—Brick and Other Clays of Des Moines. *Proc. Iowa Acad. Sci.*, 1890–91.

Keyes, C. R.—Clay Deposits of Lee Counties. Ia. Geol. Surv., *Ann. Rept.*, **3**, 389–96 (1893).

Keyes, C. R.—Clay Industries of Des Moines County. Ia. Geol. Surv., *Ann. Rept.*, **3**, 479–83 (1893).

Keyes, C. R.—Lithology of the Coal Measures. Ia. Geol. Surv., *Ann. Rept.*, **2**, 126–31 (1894).

Lees, James H.—The Clay Deposits of Iowa in General, and of Mason City in Particular. *The Clayworker*, **50**, 610–2 (1908).

Leonard, A. G.—Clays of Dallas County. Ia. Geol. Surv., *Ann. Rept.*, **8**, 101–7 (1897).

Leonard, A. G.—Clay of Wapello County. Ia. Geol. Surv., *Ann. Rept.*, **12**, 493–6 (1901).

Leonard, A. G.—Clays of Clayton County. Ia. Geol. Surv., *Ann. Rept.*, **16**, 293–6 (1905).

Lonsdale, E. H.—Clays and Their Uses. (Montgomery County.) Ia. Geol Surv., *Ann. Rept.*, **4**, 437–45 (1894).

MacBride, T. H.—Clays of Humboldt County. Ia. Geol. Surv., *Ann. Rept.*, **9**, 143 (1898).

MacBride, T. H.—Brick Clay of Osceola and Dickinson Counties. Ia. Geol. Surv., *Ann. Rept.*, **10**, 226 (1899).

MacBride, T. H.—Brick Clay of Clay and O'Brien Counties. Ia. Geol. Surv., *Ann. Rept.*, **11**, 486, 491 (1900).

MacBride, T. H.—Brick and Tile of Cherokee and Buena Vista Counties. Ia. Geol. Surv., *Ann. Rept.*, **12**, 341–2 (1901).

MacBride, T. H.—Clays of Kossuth, Hancock, and Winnebago Counties. Ia. Geol. Surv., *Ann. Rept.*, **13**, 108 (1902).

MacBride, T. H.—Clays of Emmet, Palo Alto, and Pocahontas Counties. Ia. Geol. Surv., *Ann. Rept.*, **15**, 256, 257 (1904).

MacBride, T. H.—Clays of Sac and Ida Counties. Ia. Geol. Surv., *Ann. Rept.*, **16**, 543, 544 (1905).

Marston, A., Beyer, S. W., Bissell, G. W., Williams, I. A. and Weems, J. B.—

Clays and Clay Products of Iowa (1904). Reviewed in *Nature*, **72**, 388–9 (1905).

Miller, B. L.—Clays of Marion County. Ia. Geol. Surv., *Ann. Rept.*, **11**, 189–91 (1900).

Norton, W. H.—Clays of Linn County. Ia. Geol. Surv., *Ann. Rept.*, **4**, 190–3 (1894).

Norton, W. H.—Clays of Scott County. Ia. Geol. Surv., *Ann. Rept.*, **9**, 499–503 (1898).

Norton, W. H.—Clay of Cedar County. Ia. Geol. Surv., *Ann. Rept.*, **11**, 387–8 (1900).

Norton, W. H.—Clay of Bremer County. Ia. Geol. Surv., *Ann. Rept.*, **14**, 392–3 (1905).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, pp. 1139, 1140 (1897).

Savage, T. E.—Clays of Benton County. Ia. Geol. Surv., *Ann. Rept.*, **15**, 221–3 (1904).

Savage, T. E.—Clay of Fayette County. Ia. Geol. Surv., *Ann. Rept.*, **15**, 537–40 (1904).

Savage, T. E.—Clay of Henry County. Ia. Geol. Surv., *Ann. Rept.*, **12**, 300, 301 (1901).

Savage, T. E.—Clays of Jackson County. Ia. Geol. Surv., *Ann. Rept.*, **16**, 646–7 (1905).

Savage, T. E.—Clays of Tama County. Ia. Geol. Surv., *Ann. Rept.*, **13**, 250–3 (1902).

Stokes, H. N.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 359 (1904).

Tilton, J. L.—Clays of Warren County. Ia. Geol. Surv., *Ann. Rept.*, **5**, 356–9 (1895).

Tilton, J. L. and Bain, H. F.—Clays of Madison County. Ia. Geol. Surv., *Ann. Rept.*, **7**, 535 (1896).

Udden, J. A.—Clay of Jefferson County. Ia. Geol. Surv., *Ann. Rept.*, **12**, 432–3 (1901).

Udden, J. A.—Clay Industries of Clinton County. Ia. Geol. Surv., *Ann. Rept.*, **15**, 426–7 (1904).

Udden, J. A.—Clay Industries of Louisa County. Ia. Geol. Surv., *Ann. Rept.*, **11**, 119–20 (1900).

Udden, J. A.—Clay Industries of Mills and Fremont Counties. Ia. Geol. Surv., *Ann. Rept.*, **13**, 178–9 (1902).

Udden, J. A.—Clay Industries of Muscatine County. Ia. Geol. Surv., *Ann. Rept.*, **9**, 372–4 (1898).

Udden, J. A.—Clay Industries of Pottawattamie County. Ia. Geol. Surv., *Ann. Rept.*, **11**, 270–2 (1900).

Weems, J. B., Beyer, S. W., Bissell, G. W., Williams, I. A. and Marston, A.—Clays and Clay Industries of Iowa (1904). Reviewed in *Nature*, **72**, 388–9 (1905).

Whitford, W. G. and O. J. Whittemore.—Possibilities of Pottery Manufacture from Iowa Clays. Iowa State College of Agriculture, **19**, No. 4, *Bull.* **58**.

Wilder, F. A.—Clays of Lyon and Sioux Counties. Ia. Geol. Surv., *Ann. Rept.*, **10**, 149–51 (1899).

Wilder, F. A.—Clay of Webster County. Ia. Geol. Surv., *Ann. Rept.*, **12**, 174–9 (1901).

Williams, I. A.—Clay of Franklin County. Ia. Geol. Surv., *Ann. Rept.*, **16**, 501–3 (1905).

Williams, I. A.—Clay of Jasper County. Ia. Geol. Surv., *Ann. Rept.*, **15**, 348–54 (1904).

Youtz, L. A.—Clays of the Indianola Brick, Tile and Pottery Works (Warren Co., Iowa). *Iowa Acad. Sci. Proc.*, **3**, 40–44 (1896).

Kansas

Adams, G. I., Haworth, E. and Crane, W. R.—Clays in Iola Quadrangle. U. S. Geol. Surv., *Bull.* **238**, Econ. Geol. of the Iola Quad., pp. 70–4 (1904).

Gould, C. N.—Dakota Cretaceous of Kansas and Nebraska. *Trans. Kans. Acad. Sci.*, **17**, 150 (1901).

Grimsley, G. P.—Kansas Mineral Products.

Kans. Board of Agric., *Eleventh Bien. Rept., 1897–98*, p. 507 (1898).

Grimsley, G. P.—The Early Clay Industry of Kansas. *Trans. Kans. Acad. Sci.*, **17**, 200–7 (1901).

Hay, R.—The River Countries of Kansas: Some Notes on Their Geology and Mineral Resources. *Trans. Kans. Acad. Sci.*, **14**, 230–60 (1896).

Haworth, E.—The River Counties of Kansas. Clays. *Trans. Kans. Acad. Sci.*, **14**, 243–5, 252–3, 258 (1893–94).

Haworth, E.—Annual Bulletins on Mineral Resources of Kansas issued by Kans. Geol. Surv. as follows: 1897, p. 81; 1898, p. 61; 1899, p. 57; 1900–01, p. 60; 1902, p. 40,

Haworth, E.—Clay Beds of the Kansas Tertiary. *Kans. Univ. Geol. Surv.*, **2**, 273 (1897).

Haworth, E.—Clay, Useful Minerals of Kansas. U. S. Geol. Surv., *Bull.* **624**, 135–8 (1917).

Haworth, E. and Adams, G. I.—Brick-making. Characteristics and Properties of Clays of the Iola quadrangle, Kans. U. S. Geol. Surv., *Bull.* **238**, 69–74 (1904).

Hay, R.—Geology and Mineral Resources of Kansas. State Agric. Board, *Eighth Bien. Rept., 1891–92*, p. 54 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 515 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, pp. 731–3 (1893).

Hinds, H. and Grane, F. C.—Clay of the Leavenworth Region. Description of Leavenworth and Smithville Quadrangle. U. S. Geol. Surv., *Atlas Folio*, **206** (1917).

Prosser, C. S.—Clay Deposits of Kansas. U. S. Geol. Surv., *Mineral Resources for 1892*, pp. 731–3 (1894).

Sanford, S. and Stone, R. W.—Useful Minerals of Kansas. U. S. Geol. Surv., *Bull.* **585**, pp. 78–80 (1914).

Schrader, F. C. and Haworth, E.—Clay Industries of the Independence Quadrangle, Kansas. U. S. Geol. Surv., *Bull.* **260**, pp. 546–59 (1905). (Abs., *Geol. Centralb.*, **10**, p. 444 (1907–08).)

Teetor, P.—Clay and Shale Resources in the Vicinity of Arkansas City, Kansas. Kans. State Geol. Surv., *Bull.* **8**, 38–47 (1921).

Teetor, P.—The Clays of Eastern Kansas. *Trans. Amer. Ceram. Soc.*, **16**, 120–6 (1914).

Kentucky

Anon.—The Kaolin Deposits of Southern Kentucky. *The Clayworker*, **44**, 460 (1905).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.*, **2**, 790–3 (1919).

Berry, E. W.—The Lower Eocene Flora of Southeastern N. America. U. S. Geol. Surv., *Prof. Paper* **91** (1916).

Butts, C.—Descriptions and Correlation of the Mississippian Formations of Western Kentucky. Ky. Geol. Surv. (1912).

Butts, C.—Geology of Jefferson County, Ky. Ky. Geol. Surv. (1914–15).

Campbell, M. R.—U. S. Geol. Surv., *Atlas Folio*, London and Richmond Quadrangles.

Clarke, F. W.—Analyses of Clays. Analyses of Rocks, 1880–1903 (Fire Clay from Carter Co., Ky.). U. S. Geol. Surv., *Bull.* **228**, 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, p. 282 (1897).

Crandall, A. R.—Report on the Geology of Greenup, Carter and Boyd Counties, Ky. Ky. Geol. Surv., Vol. C, Eastern Coal Field, pp. 1–78 (1884).

Crandall, A. R. and Sullivan, G. M.—The Coal Field Adjacent to Pineville Gap. Ky. Geol. Surv., *Bull.* **14**, Serial No. 17 (1912).

Crider, A. F.—Clays of Western Kentucky and Tennessee. U. S. Geol. Surv., *Bull.* **285,** pp. 417–27 (1906).

Crider, A. F.—The Fire Clays and Fire Clay Industries of the Olive Hill and Ashland Districts of Northeastern Kentucky. Ky. Geol. Surv., *4th Ser.*, **1,** 589–711 (1913).

Crump, M. H.—Clays and Building Stones in Kentucky. *Eng. and Min. Jour.*, **66,** 190 (1898).

Easton, H. D.—Report on the Technology of Kentucky Clays. Including Chemical and Mechanical Analyses, and Burning Tests. Ky. Geol. Surv., *4th Ser.*, **1** (Pt. II), 713–888 (1913).

Eckel, E. C.—Clay Resources of Northeastern Kentucky. U. S. Geol. Surv., *Bull.* **288** (1906).

Foerste, A. F.—Silurian Clays, with Notes on Clays of the Waverly and Irvine Formations of Kentucky. Ky. Geol. Surv., *Bull.* **6,** pp. 143–78 (1905).

Foerste, A. F.—The Silurian, Devonian, and Irvine Formations of East Central Ky., with an Account of Their Clays and Limestones. Ky. Geol. Surv., *Bull.* **7** (1906); also *Bull.* **6,** p. 146 (1905).

Fohs, F. J.—Clays in Crittenden and Livingston Counties, Ky. Ky. Geol. Surv., *Bull.* **6** (1905).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14,** 301–46 (1912).

Gardner, J. H.—Clays of the Red River Valley, Kentucky. Ky. Geol. Surv., *Bull.* **6,** pp. 64–79 (1905).

Gardner, J. H.—Clays and Sands of the Jackson Purchase Region. Ky. Geol. Surv., *Bull.* **6** (1905).

Gardner, J. H.—The Kaolins and Plastic Clays of the Eastern Rim of the Western Coalfield, Kentucky. Ky. Geol. Surv., *Bull.* **6** (1905).

Gardner, J. H.—Miscellaneous Analyses of Kentucky Clays and Marls. Kentucky Geol. Surv., *Bull.* **6,** pp. 179–223 (1905).

Gardner, J. H.—Preliminary Report on the Economic Geology of the Hartford Quadrangle. Ky. Geol. Surv., *Bull.* **20,** 1–25 (1912).

Glenn, L. C.—A Geological Reconnaissance of the Tradewater Region with Special Reference to the Coal Beds. Ky. Geol. Surv., *Bull.* **17,** Serial 27 (1912).

Glenn, L. C.—The Underground Waters of the Eastern United States, Tennessee and Kentucky. U. S. Geol. Surv., *Water Supply and Irrigation Paper.*, No. 164 (1906).

Greaves-Walker, A. F.—The Flint Fire Clay Deposits of Northeastern Kentucky. *Trans. Amer. Ceram. Soc.*, **9,** 461–72 (1907); *Ibid.*, **8,** 297 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 509 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* p. 724 (1893).

Hutchinson, F. M.—The Geology and Coals of Central City, Madisonville, Calhoun and Newburg Quadrangles; in Muhlenberg, Hopkins, Ohio, McLean, Webster, Daviess and Henderson Counties. Ky. Geol. Surv., *Bull.* No. **19,** Serial No. 26 (1912).

Loughridge, R. H.—The Geological and Economic Features of the Jackson Purchase Region. Ky. Geol. Surv., pp. 355 (1888).

Loughridge, R. H.—Report on the Geology of Clinton County, with Map. Ky. Geol. Surv., 48 pp. (1890?).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Miller, A. M.—Discussion on "Fire Clays of the Eastern Coalfield of Kentucky." *Jour. Amer. Cer. Soc.*, **5** [8], 161 (1922).

Miller, A. M.—The Geology of Kentucky. Dept. Geol. and Forestry, Ser. V, *Bull.* **2,** 329–34 (1919).

Peter, R.—Chemical Report of the Coals, Clays, Mineral Water, etc., of Ken-

tucky. Ky. Geol. Surv., *Bull.* No. **3** (1905).

Phalen, W. C.—Clay Resources of Northeastern Kentucky. U. S. Geol. Surv., *Bull.* **385,** 411–6 (1906).

Phalen, W. C.—Description of the Kenova Quadrangle. U. S. Geol. Surv., Geol. Atlas, *Kenova Folio,* No. **184** (1912). (Abs., *Jour. Wash. Acad. Sci.,* **3,** 455 (1913).)

Phalen, W. C. Economic Geology of the Kenova Quadrangle. U. S. Geol. Surv., *Bull.* **349** (1908).

Ries, H.—The Clay Deposits of Kentucky. Ky. Geol. Surv., Ser. 6, **8** (1922).

Ries, H.—Fire Clays of the Eastern Coal Field of Kentucky. *Jour. Amer. Ceram. Soc.,* **5** [7], 397 (1922).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.,* **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** pp. 226, 236–8, 276–82 (1921).

Ries, H., and Leighton, H.—History of the Clay Working Industry in the United States (1909).

Ulrich, E. O. and Smith, W. S. T.—Lead, Zinc and Fluorspar Deposits of Western Kentucky. U. S. Geol. Surv., *Prof. Paper* **36** (1905).

Louisiana

Clendennin, W. W.—Clays of Louisiana. *Eng. and Min. Jour.,* **66,** 456–7 (1898).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 507 (1892).

Matson, G. C.—Louisiana Clays. U. S. Geol. Surv., *Bull.* **660** (1917).

Ries, H.—A Report on Louisiana Clay Samples. A Preliminary Report on the Geology of Louisana by G. D. Harris and A. C. Veatch. La. Expt. Sta., Pt. 5, pp. 263–75 (1899). (Review, *Jour. Geol.,* **11,** 548.)

Maine

Bastin, E. S.—Clays of the Penobscot Bay Region, Maine. U. S. Geol. Surv., *Bull.* **285,** 428–31 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 194 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Katz, F. J.—Clay in the Portland Region, Maine. U. S. Geol. Surv., *Bull* **530,** 202–6 (1913).

Monell, W.—The Clay Industries of Maine. *Eng. and Min. Jour.,* **66,** 161 (1898).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** p. 132 (1903).

Maryland

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.,* **2** [10], 790–93 (1919).

Clark, W. B.—Brief Account of Maryland Mineral Resources and Description of Exhibit of Maryland Mineral Products (Clays). Prepared for St. Louis Exposition, 1904. Clays, p. 3.

Clark, W. B.—Clays. Md. Geol. Surv., *The Geography of Md.,* **10,** 105, 106, 161 (1918).

Clark, W. B.—Clays, pp. 34, 214; Porcelain Materials, pp. 35, 216. Maryland Geol. Surv., **1** (1897).

Clark, W. B.—Maryland and Its Natural Resources. Official Publication of Maryland Commissioners Pan-American Exposition, Baltimore, 1901. Clays, p. 16.

Clark, W. B.—Maryland Mineral Industries, 1896–1907. Md. Geol. Surv., Vol. **8**, pp. 109–16 (1909).

Clark, W. B.—Physical Features of Maryland. Md. Geol. Surv., **1** (1897). (Clay, pp. 214–6.)

Clark, W. B.—The Relation of Maryland Topography, Climate and Geology to Highway Construction. Md. Geol. Surv., **3** (1899). (Sands and Clays, p. 104.)

Clark, W. B. and Mathews, E. B.—The Clays and Clay Products. Md. Geol. Surv., *The Physical Features of Maryland*, **6**, 191–6 (1906).

Clark, W. B. and Mathews, E. B.—Clays and Clay Products. Md. Geol. Surv., *Md. Min. Ind.*, **8**, 109–18 (1909).

Clark, W. B., O'Harra, C. C., Rowe, R. B. and Ries, H.—The Mineral Resources of Allegany County, Md. (Clays). Md. Geol. Surv., Allegany County, pp. 180–5, 194 (1900).

Dorsey, C. W.—Soil Formations. Md. Geol. Surv., *Rept. on Allegany County*, pp. 200–13 (1900).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, pp. 199 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 504 (1892).

Kennicutt, L. P. and Rogers, J. F.—Fire Clays from Mt. Savage, Allegany County, Md. *Jour. Anal. and App. Chem.*, **5**, 101, 542–4 (1891). (Abs., *Jour. Iron and Steel Inst.*, **1**, 306 (1892).)

Little, H. P.—The Clays. Md. Geol. Surv., *Rept. on Anne Arundel County* pp. 119–22 (1917).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Martin, G. C.—Clays. Md. Geol. Surv., *Rept. on Garrett Co.*, pp. 212–20 (1902).

Mathews, E. B.—The Mineral Resources of Cecil County. Md. Geol. Surv., *Rept. on Cecil County*, pp. 204–17 (1902).

Mathews, E. B. and Grasty, J. S.—Clays. Md. Geol. Surv., **8**, *Rept. on the Limestones of Maryland*, pp. 297–9, 347, 348 (1909).

Mathews, E. B., Watts, A. S., Schurecht, H. G., Swartz, C. K. and Hall, G. M.—The Fire Clays of Maryland. Md. Geol. Surv., **11**, pp. 291–539 (1922).

Miller, B. L.—Economic Resources of Calvert Co. Md. Geol. Surv., *Rept. on Calvert Co.*, pp. 123–34 (1907).

Miller, B. L.—Economic Resources of St. Marys County. Md. Geol. Surv., *Rept. on St. Marys County*, pp. 113–24 (1907).

Miller, B. L.—Prince Georges County—Physiography, Geology and Mineral Resources. Md. Geol. Surv., *Rept. on Prince Georges County*, pp. 24–150 (1911).

O'Harra, C. C.—Clays. Md. Geol. Surv., *Rept. on Allegany County*, pp. 87, 130 (1900).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, pp. 134–48 (1903).

Ries, H.—Report on the Clays of Maryland. Md. Geol. Surv., **4**, pp. 203–505 (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, pp. 18, 201, 204 (1921).

Singewald, J. T., Jr.—Analysis of Blue Clay. Md. Geol. Surv., *Rept. on the Iron Ores of Md. with an Account of the Iron Industry*, **9**, pp. 196, 236, 237.

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 353 (1904).

Massachusetts

Anon.—Clays and Clayworking in Massachusetts. *The Clayworker*, **58,** 173 (1912).

Alden, W. C.—Fullers' Earth and Brick Clays near Clinton, Mass. U. S. Geol. Surv., *Bull.* **430,** 402–4 (1910).

Brown, R. M.—The Clays of the Boston Basin. *Amer. Jour. Sci.*, **14,** 4th Ser., 445–50 (1902).

Clarke, F. W.—Analysis of Clays. U. S. Geol. Surv., *Bull.* **228,** Analyses of Rocks, 1880–1903; (from Mass.) p. 351 (1904).

Clarke, F. W.—Analyses of Eight Clays, etc., from Martha's Vineyard, Mass. U. S. Geol. Surv., *Bull.* **55,** pp. 89–90 (1889).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 287 (1897).

Crosby, W. O.—The Kaolin in Blandford, Mass. *Tech. Quarterly*, **3** [3], 228–337 (1890).

Emerson, B. K.—A Mineralogical Lexicon of Franklin, Hampshire, and Hampden Counties, Mass. U. S. Geol. Surv., *Bull.* **126,** Kaolinite, pp. 97–9 (1865).

Fuller, M. L.—Clays of Cape Cod, Mass. U. S. Geol. Surv., *Bull.* **285,** 432–41 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 502 (1892).

Hitchcock, E.—Final Report on the Geology of Mass. Vol. 1. Economical Geology, 1841. (Clay in the manufacture of alum, fire brick, etc., 215; glazing for porcelain, p. 221; Clay for Brick, pp. 183–84), also *Amer. Jour. Sci.*, **22,** 37 (1832).

Hitchcock, E.—Report on the Geology, Mineralogy, Botany and Zoölogy of Massachusetts, 1883. (Porcelain Clay, p. 36; Potter's Clay, p. 37; Clays, p. 38.)

Hollis, F. S.—Kaolin in Ashland, Mass. Technology Quarterly, **5,** 108–13 (1892).

Ries, H.—Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 149–53 (1903).

Sears, J. H.—The Physical Geography, Geology, Mineralogy and Paleontology of Essex County, Massachusetts (1905). Clays, p. 357.

Shaler, N. S.—The Brickmaking Clays of Massachusetts. U. S. Geol. Surv., *16th Ann. Rept., 1894–95, Pt. II*, pp. 324–6 (1895).

Shaler, N. S., Woodworth, J. B. and Marbut, C. F.—The Glacial Brick Clays of Rhode Island and Southeastern Massachusetts. U. S. Geol. Surv., *17th Ann. Rept.* [*Pt. I*], pp. 951–1004 (1896).

Whittle, Chas. L.—The Clays and Clay Industry of Massachusetts. *Eng. and Min. Jour.*, **66,** 245–6 (1898).

Whittle, Chas. L.—The Clay Industry of Massachusetts. *Min. Ind., 1898*, **7,** 125–8 (1899).

Michigan

Anon.—Mineral Resources of Michigan. Mich. Geol. and Biol. Surv., No. **32,** pp. 61–9.

Brown, G. G.—The Clays and Shales of Michigan and Their Uses. Mich. Geol. Surv., *Pub.* **36,** Geol. Ser. 30.

Cooper, W. F.—Geological Report on Bay County. Mich. Geol. Surv., *Rept. for 1905*, pp. 389–94 (1906).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 216–22 (1913).

Fall, D.—Marls and Clays of Michigan. Mich. Geol. Surv., **8** [Pt. 3], pp. 343–53 (1903); *Mich. Eng.*, p. 124–33 (1901); *Mich. Miner*, **3** [11], pp. 11–14 (1901).

Gordon, C. H.—Geological Report on

Sanilac County. Mich. Geol. Surv., **7** [3], 23, 25 (1900).

Grabau, A. W.—Stratigraphy of the Traverse Group of Michigan. *Rept. Geol. Surv. Mich. for 1901*, pp. 163, 188, 189, 192, 195 (1902).)

Hale, D. J. and Others.—Report on Marl (Bog Lime). Mich. Geol. Surv., **8** [3] (1903). Short notes and analyses on many pages, especially p. 345.

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 522 (1892).

Lane, A. C.—Geological Report on Huron County. Mich. Geol. Surv., **7** [2], 208–11 (1900).

Lane, A. C.—The Clays of Alcona County, Mich. Geol. Surv. of Mich., 1901, pp. 61–3 (1902).

Lane, A. C.—Michigan Clays, Shales and Paving Materials. *The Gateway*, pp. 49–51, Jan. (1904). (Abs., *Geol. Centralb.*, **5**, p. 254 (1904).)

Lane, A. C.—Report of State Board of Geological Survey of Michigan 1903. Analyses of clays. Pp. 184–8 (1905).

Lane, A. C.—*Sixth Annual Report of State Geologist for 1904*, p. 120 (1905).

Lane, A. C.—List of Localities and Mills Manufacturing Portland Cement. Occurrence and Analysis of Clays. Mich. Geol. Surv., **8** [Pt. 3], pp. 224–342 (1903).

Lane, A. C.—*Eighth Annual Report of State Geologist for 1906*, p. 587 (1907).

Ries, H.—Clays and Shales of Michigan Geol. Surv., . Mich., **8** [Pt. I], 1900.

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 153–9 (1903).

Ries, H.—The Shales of Michigan. *Stone*, **21**, 20–24 (1900).

Russell, J. C.—A Geological Reconnaissance along the North Shores of Lakes Huron and Michigan. *Rept. State Board of Geol. Surv. of Mich., 1904*, pp. 93–4 (1905).

Sherzer, W. H.—Geological Report on Monroe County. Mich. Geol. Surv., **7** [1], p. 188 (1900).

Sherzer, W. H.—Geology of Wayne County. Mich. Geol. and Biol. Surv., *Publication* **12**, pp. 265–9 (1911).

Smith, R. A.—Mineral Resources of Michigan. Mich. Geol. and Biol. Surv., *Pub.* **19**, Geol. Ser., 16, pp. 302–8 (1915).

Minnesota

Berkey, Charles P.—Origin and Distribution of Minnesota Clays. *Amer. Geol.*, **29**, 171–7 (1902). (Abs., *Geol. Centralb.*, **5**, 254 (1904).)

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 359 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 293 (1897).

Grout, F. F.—The Clays of Minnesota. *Jour. Geog.*, **14**, 185–87 (1916).

Grout, F. F.—Clays and Shales of Minnesota. U. S. Geol. Surv., *Bull.* **678**, 259 pp. (1919). (Abs. by R. W. Stone, *Jour. Wash. Acad. Sci.*, **9** [19], 600 (1919).)

Grout, F. F. and Soper, E. K.—Preliminary Report on the Clays and Shales of Minnesota. Geol. and Nat. Hist. Surv. of Minn., *Bull.* **11**, 1914. (Issued also as U. S. Geol. Surv., *Bull.* **678.**)

Winchell, N. H.—The Geology of Minnesota. The Geological and Natural History Survey of Minnesota, *Final Report*, **1** (1872–1882), **2** (1882–1885), **4** (1896–1898).

Winchell, N. H.—Preliminary Report On the Building Stones, Clays, Limes, Cements, Roofing, Flagging and Paving Stones of Minnesota. Minn. Geol. Surv., *Ann. Rept.*, **8**, 60–69 (1880).

Mississippi

Anon.—Clay and Cement in Mississippi. *Eng. and Min. Jour.*, **82,** 1062 (1906).

Bledsoe, O. F.—The Clays of Mississippi. *The Clayworker*, **40,** 277–8 (1903).

Burchard, E. F.—Bauxite Associated with Siderite. Geol. Soc. Amer., *Bull.* **25,** 437–8 (1924).

Burchard, E. F.—Bauxite in Northeastern Mississippi. U. S. Geol. Surv., *Bull.* **750,** 101–46 (1925).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 292 (1897).

Crider, A. F.—Clays of Mississippi. Miss. Geol. Surv., *First Biennial Report* (1908).

Crider, A. F.—The Geology and Mineral Resources of Mississippi. U. S. Geol. Surv., *Bull.* **283.** (Abs. in *The Clayworker*, **46,** 497 (1906).)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 244 (1913).

Eckel, E. C.—Stoneware and Brick Clays of Western Tennessee and Northwestern Mississippi. U. S. Geol. Surv., *Bull.* **213,** 382–91 (1903).

Emmons, S. F. and Hayes, C. W.—Contributions to Economic Geology. U. S. Geol. Surv., *Bull.* **260,** 515 (1905).

Hilgard, E. W.—Report on the Geology of Mississippi, p. 244 (1844).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 508 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 616 (1894).

Hutchinson, W. L.—Analyses of Clays from Mississippi. Miss. Agricultural and Mech. College, Exper. Sta., *8th Ann. Rept.*, p. 105 (1895).

Logan, W. N.—Brick Clays and Clay Industry of Northern Mississippi. Miss. Geol. Surv., *Bull.* **2** (Pt. I).

Logan, W. N.—Clays of Mississippi, Pt. 2. Brick Clays and Clay Industry of Southern Mississippi. Miss. State Geol. Surv., *Bull.* **4,** 72 pp. (1904). (Abs., *Geol. Centralb.*, **13,** 363 (1909–10).)

Logan, W. N.—The Pottery Clays of Mississippi. Miss. Geol. Surv., *Bull.* **6** (1914). (Abs. in *Min. and Eng. Mag.*, **90,** 369 (1910).)

Logan, W. N. and Hand, W. F.—A Preliminary Report on Some of the Clays of Mississippi. Miss. Geol. Surv., *Bull.* **3** (Miss. Agricultural and Mech. Coll., *Bull.* **2** [3], 88 (1905).)

Lowe, E. N.—Clays. Miss. Geol. Surv., *3rd Biennial Report* (1911).

Lowe, E. N.—Clays. Miss. Geol. Surv., *5th Biennial Report* (1915).

Lowe, E. N.—Clays. Miss. Geol. Surv., *7th Biennial Report* (1919).

Lowe, E. N.—Clays. Miss. Geol. Surv., *8th Biennial Report* (1921).

Lowe, E. N.—Mississippi: Its Geology, Geography, Soils and Mineral Resources. Miss. Geol. Surv., *Bull.* **12** (1915).

Lowe, E. N.—Mississippi: Its Geology, Geography, Soils and Mineral Resources. Miss. Geol. Surv., *Bull.* **14** (1919).

Lowe, E. N.—Mineral Resources of Mississippi. *Manufacturers Record*, Dec. 11 (1924).

Lowe, E. N.—A Questionnaire on the Mineral Resources of Mississippi, and the Work of the State Geological Survey. Miss. Geol. Surv., *Bull.* **18** (1923).

Morse, P. F.—The Bauxite Deposits of Mississippi. Miss. Geol. Surv., *Bull.* **19** (1922).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 159–61 (1903).

Ries, H., Bayley W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 206–11, 235–6, 239–55 (1921).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

E. C. Sullivan.—Stoneware Clay from Holly Springs, Miss. Analyses of Clays. Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228,** 357 (1904).

Missouri

Broadhead, G. C.—Adair County (Mo.). *Rept. Geol. Surv. Missouri, 1873–74,* p. 255 (1874).

Buckley, E. R.—Public Roads, Their Improvement and Maintenance. Mo. Bur. Geol. and Mines, *2nd Series,* **5,** 124 pp. (1907).

Buckley, E. R., Smith, A. F. and Ball, S. H.—Geology of Miller County. Mo. Bur. Geol. and Mines, *2nd Series,* **1,** 207 pp. (1913).

Buehler, H. A.—The Lime and Cement Resources of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **6,** 255 pp. (1907).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 45th General Assembly,* 59 pp. (1909).

Buehler, H. A.—Mo. Bur. Geol. and Mines *Biennial Report of the State Geologist to the 47th General Assembly,* 54 pp. (1913).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 48th General Assembly,* 62 pp. (1915).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 49th General Assembly,* 75 pp. (1917).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 50th General Assembly,* 117 pp. (1919).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 51st General Assembly,* 87 pp. (1921).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 52nd General Assembly,* 133 pp. (1923).

Buehler, H. A.—Mo. Bur. Geol. and Mines, *Biennial Report of the State Geologist to the 53rd General Assembly,* (1925).

Chatard, T. M.—Analyses of "Tallow Clays." U. S. Geol. Surv., *Bull.* **90,** 64 (1892).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 295, 296 (1897).

Dake, C. L.—The Sand and Gravel Resources of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **15,** 250 pp. (1918).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 248–49 (1913).

Fenneman, N. M.—Clay Resources of the St. Louis District, Mo. U. S. Geol. Surv., *Bull.* **315,** 315–21 (1907).

Fenneman, N. M.—Geology and Mineral Resources of the St. Louis Quadrangle, Missouri-Illinois. U. S. Geol. Surv., *Bull.* **438** (1911).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14,** 301–46 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891,* p. 511 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1893,* p. 616 (1894).

Hinds, H.—The Coal Deposits of Missouri. Mo. Bur. Geol. and Mines, *2nd Series,* **11,** 503 pp. (1912).

Hinds, H. and Greene, F. C.—Leavenworth and Smithville Quadrangles. U. S. Geol. Surv., *Geologic Folio,* **206.**

Hinds, H. and Greene, F. C.—The Stratigraphy of the Pennsylvania Series in

Missouri. Mo. Bur. Geol. and Mines, *2nd Series*, **13**, 500 pp. (1915).

Keyes, C. R.—Distribution and Character of Missouri Clays. *Min. Ind.*, **5**, 127–37 (1897).

Keyes, C. R.—Geological Occurrence of Clays. Missouri Geol. Surv., **11**, 35–48 (1896).

Keyes, C. R., Winslow, A., Gordon, C. H., Haworth, E. and Nason, F. L.—Reports on Areal Geology (sheets 1 and 2). Mo. Bur. Geol. and Mines, *1st Series*, **9**, 430 pp. (1896).

Ladd, G. E.—The Clay, Stone, Lime and Sand Industries of St. Louis, Mo., City and County. Geol. Surv. Mo., *Bull.* **3**, 5–37 (1890).

Ladd, G. E.—Notes on Certain Undescribed Clay Occurrences in Missouri. *Science* (New Series), **3**, 691–3 (1896).

Ladd, G. E.—Notes on the Clays and Building Stones of Certain Western Central Counties Tributary to Kansas City. Geol. Surv. Mo., *Bull.* **5** (1891).

Lee, W.—The Geology of the Rolla Quadrangle. Mo. Bur. Geol. and Mines, *2nd Series*, **12** (1913).

Marbut, C. F.—Clay Deposits of the Huntsville Quadrangle. Mo. Geol. Surv., **12**, 362–5 (1898).

Marbut, C. F.—Geology of Lexington Sheet. Geol. Surv. of Missouri, **12**, [Pt. 2], 243–5 (1898).

Marbut, C. F.—The Geology of Morgan County. Mo. Bur. Geol. and Mines, *2nd Series*, **7**, 97 pp. (1906).

Marbut, C. F.—Geology of Richmond Quadrangle. Mo. Geol. Surv. **12**, [Pt. 2], 299–302 (1898).

McCourt, W. E., Albertson, M. and Bennett, J. W.—The Geology of Jackson County. Mo. Bur. Geol. and Mines, *2nd Series*, **14**, 158 pp. (1917).

Mühlhäuser, O.—Der Thon von St. Louis. *Z. f. angewandte Chemie*, pp. 148–59(1903). (Abs., *Geol. Centralb.*, **5**, 253 (1904).)

Orton, E., Jr.—The Kaolin Deposits of Bollinger County, Missouri. *Trans. Amer. Ceram. Soc.*, **9**, 62–94 (1907).

Ries, H.—The Clay Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept. 1896-97* [*Pt. V*] (*cont.*), p. 1140–3 (1897).

Ries, H.—Occurrence of Glass-Pot Clays in the U. S. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 135–47, 104–8 (1921).

Rowley, R. R.—The Geology of Pike County. Mo. Bur. Geol. and Mines, 2nd Series, **8**, 122 pp. (1908).

Schmidt, A. and Leonhard, A.—The Lead and Zinc Regions of Southwest Missouri. Rept. Geol. Surv. Missouri, 1873–74, pp. 407–9, 515–6 (1874).

Seamon, W. H.—Zinciferous Clays of Southwest Missouri. *Amer. Jour. Sci.*, Jan., p. 38 (1890); *Sci. Amer. Supp.*, **30**, 122–87 (1890).

Shepard, E. M.—A Report on Greene County (Mo.). Geol. Surv. of Mo., **12** [Pt. 1], 212–20 (1898).

Shepard, E. M., Marbut, C. F. and Broadhead, G. C.—Areal Geology. Mo. Bur. Geol. and Mines, 1st Series, **12**, Sheets 5–10, 656 pp. (1898).

Stokes, H. N.—Analyses of Rocks 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 362 (1904).

Thornberry, M. H.—A Treatise on Missouri Clays. Issued by School of Mines and Metallurgy, Rolla, Mo. (1925).

Van Horn, R. B.—The Geology of Moniteau County. Mo. Bur. Geol. and Mines, *2nd Series*, **3**, 104 pp. (1905).

Wheeler, H. A.—Clay Deposits. Mo. Bur. Geol. and Mines, *1st Series*, **11**, 622 pp. (1896).

Wheeler, H. A.—Clay Deposits of the Clinton Sheet. Geol. Surv. of Mo., **12** (Pt. 2), 80–95 (1898). Clay Deposits of the Calhoun Sheet, pp. 176–83. Clay Deposits of the Huntsville Quadrangle pp. 362–5, 367–8.

Wheeler, H. A.—Clay Resources of Missouri. *Eng. and Min. Jour.*, **66,** 426–7 (1898).

Wheeler, H. A.—Clays and Shales on the Bevier Sheet. Report on the Bevier Sheet. Missouri Geol. Surv., **9,** 57–67 (1896).

Wheeler, H. A.—The Fire Clays of Missouri. Bi-monthly, *Bull. Amer. Inst. Min. Eng.*, No. **1,** 103–16 (1905). (Also *Trans. Amer. Inst. Min. Eng.*, **35,** 720–34 (1905).)

Winslow, A.—Lead and Zinc Deposits. Mo. Geol. Surv., **7,** 444–5 (1894).

Winslow, A.—Report on Higginsville Sheet. Mo. Geol. Surv., **9,** 93–5 (1896).

Woolford, F.—Clays of Washington County, Mo. *Western Jour.* (St. Louis), **1,** 168–9, 193–5 (1848).

Wysor, D. C.—Diaspore Clay of Arkansas and Missouri. *Jour. Amer. Ceram. Soc.*, **6,** 501–9 (1923).

Montana

Bauer, C. M.—Clay in Northeastern Montana. U. S. Geol. Surv., *Bull.* **540,** 369–72 (1914).

Fisher, C. A.—Clays in the Kootenai Formation near Belt, Montana. U. S. Geol. Surv., *Bull.* **340,** 417–23 (1908).

Hice, R. R.—The Working of Some Montana Clays. *Trans. Amer. Ceram. Soc.*, **14,** 602–14 (1912).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 524 (1892).

Rowe, J. P.—Economic Geology of Montana. Mont. Univ., *Bull.* **50** (Geol. Surv., No. 3), 70 pp. (1908).

Nebraska

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Barbour, E. H.—Report of the State Geologist, **1,** p. 202 (1903).

Barbour, E. H.—An Important Undeveloped Clay Bed. Neb. Geol. Surv., **4** [Pt. 6], *Bull.* **28.**

Barbour, E. H.—Preliminary Report on the Clay Industry of Nebraska. Neb. Geol. Surv., **4,** 441–93 (Separate, no date).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V (cont.)*, p. 1353 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *19th Ann. Rept. Pt. VI (cont.)*, pp. 655–56 (1898).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 257 (1913).

Fisher, C. A.—Comparative Value of Bluff and Valley Wash Deposits as Brick Material. Neb. State Board of Agric., *Ann. Rept. for 1900*, pp. 181–4.

Gould, C. N. and Fisher, C. A.—The Dakota and Carboniferous Clays of Nebraska. Neb. State Board of Agriculture, *Ann. Rept.*, pp. 185–94 (1900).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891*, p. 515 (1892).

Nevada

Barus, Carl.—Kaolinization in Geology of the Comstock Lode and the Washoe District. U. S. Geol. Surv., *Monograph*, **3,** pp. 290–308 (1882).

Buwalda, J. P.—Clays. U. S. Geol. Surv., *Bull.* **708,** 121–6 (1921).

Chatard, T. M.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 369 (1904).

Chatard, T. M.—Analyses of Two Clays from Humboldt, River Bridge, Mill City, Nevada. U. S. Geol. Surv., *Bull.* **9,** 15 (1884).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 300 (1897).

Cox, P. E. and Moulton, D. A.—A New Raw Material for Ceramic Uses. *Jour. Amer. Ceram. Soc.*, **6,** 937–9 (1923).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 121–6 (1921).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.*, **6,** 289, 342 (1889). (Adobe.)

New Hampshire

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S. for 1891,* p. 502 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 132 (1903).

New Jersey

Bascom, F.—Description of the Philadelphia District. U. S. Geol. Surv., Geol. Atlas, *Philadelphia Folio* (No. 162) (1909).

Burton.—The Clays of New Jersey. *The Clayworker,* **40,** 442–4 (1903).

Clark, W. B., Bagg, R. M., Shattuck, G. B.—Report upon the Upper Cretaceous Formations. N. J. Geol. Surv., *Ann. Rept., 1897,* p. 207 (1898).

Cook, G. H.—*Second Annual Report of the Geological Survey of the State of New Jersey for the Year 1855,* pp. 68–74, 100–2 (1856).

Cook, G. H.—*Third Annual Report on the Geological Survey of State of New Jersey for 1856,* p. 67 (1857).

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1869.* (Fire and Potter's Clays, pp. 56, 57.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1873.* (Pp. 103–4.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1874.* (Clays for Pottery and Fire Bricks, pp. 42–54.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1878.* (Miscellaneous Clay Deposits, pp. 48–69.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1879.* Pp. 168–72.

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1880.* (Fire Clays, Refractoriness, Tests, and Classification, pp. 131–52; Statistics, pp. 181–3.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1881.* (Clays, Brick and Pottery, p. 69; Statistics, pp. 77–8.)

Cook, G. H.—*Annual Report of the State Geologist (N. J.) for 1882.* (Plastic Clays and Their Uses, pp. 74–80; Statistics, pp. 172–3.)

Cook, G. H.—Clay Deposits of New Jersey. N. J. Geol. Surv., 1878.

Cook, G. H.—Clays for Pottery and Fire Brick. N. J. Geol. Surv., *Ann. Rept.*, pp. 42–6, 116 (1874).

Cook, G. H.—Cretaceous Clays. N. J. Geol. Surv., *Ann. Rept.*, p. 242, 249–56 (1868).

Cook, G. H.—Geology of New Jersey. Newark, 1868. (Clays, pp. 683–9; Brick and Tile Materials, pp. 528–31.)

Cook, G. H.—Plastic Clays, and Their Uses. N. J. Geol. Surv., *Ann. Rept.*, p. 74–83 (1882).

Darton, N. H., Bayley, W. S., Salisbury, R. D. and Kümmel, H. B.—De-

scription of the Passaic Quadrangle N. J.–N. Y. U. S. Geol. Surv., Geol. Atlas, *Passaic Folio* (No. 157) (1908).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150** [9], 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7**, 67–8.)

Dunlop, A.—On the Jersey Brick Clay. *Quart. Jour. Geol. Soc.*, London, **45**, 118 (1889).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 239 (1913).

Ferry, C.—New Jersey Clays: Their Classification and Adaptability to the Manufacture of Fire Brick. *Iron Age*, **55**, 332–3 (1895).

Ferry, C.—New Jersey Fire Clays. *Iron Age*, **57**, 698 (Mar. 19) (1896).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503 (1892).

Hollick, C. A.—The Cretaceous Clay Marl Exposure at Cliffwood, N. J. *Amer. Geol.* **18**, p. 230 (1896); *Science*, New series, **4**, 386 (1896); *Trans. N. Y. Acad. Sci.*, **16**, 124–36 (1897).

Hunt, T. S.—On the Origin of Clays on the Atlantic Seaboard. *Trans. Amer. Inst. Min. Eng.*, **6**, p. 188 (1879).

Jenkins, G. E.—Fire Brick and Clay Industry. N. J. Geol. Surv., *Ann. Rept., 1898*, pp. 195–237 (1899).

Knapp, G. N.—The Cliffwood Clays and the Matawan. *Amer. Geol.*, **33**, 23–27 (1904).

Kümmel, H. B.—Administrative Report. N. J. Geol. Surv., *Ann. Rept.*, p. 8 (1902).

Kümmel, H. B. and Knapp, G. N.—The Stratigraphy of the New Jersey Clays. N. J. Geol. Surv., *Final Rept.*, **6**, 117–209 (1904).

Newberry, J. S.—On the Raritan Clays of New Jersey. *Proc. Amer. Assoc. Adv. Sci.*, 1869.

Ries, H.—The Clays and Clay Industry of New Jersey. *Final Rept. of State Geologist*, **6** (1904).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 161–70 (1903).

Ries, H.—Note on the Tensile Strength of Raw Clays. *Trans. Amer. Ceram. Soc.*, **6**, 79 (1923). (Abst. in *Jour. Iron and Steel Inst.*, **67** [1], 560 (1905).)

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 202–4 (1921).

Rogers, H. D.—Description of the Geology of the State of N. J. Potter's Clay Formation. *Final Rept.*, pp. 179–86 (1840).

Rogers, H. D.—Description of the Geology of the State of N. J. *Final Rept.*, pp. 131–8 (1865).

Rogers, H. D.—Geology of the Counties of Middlesex, Monmouth, Burlington, Gloucester, Salem, Cumberland and Cape May. N. J. Geol. Surv., *Ann. Rept.*, p. 17–25 (1836).

Rogers, H. D.—Geology of the "Marl Tract," Embracing Portions of Middlesex, Monmouth, Burlington, Gloucester and Salem Counties. N. J. Geol. Surv., *Ann. Rept.*, p. 26 (1836).

Sharkey, S. M.—The Clays of Mercer County, New Jersey. *N. J. Ceramist*, **1** [2], 131–6 (1921).

Smock, J. C.—Clay and Brick Industry of New Jersey. *Ann. Rept. of State Geologist of New Jersey for Year 1897*, pp. 324–50, 355–7.

Smock, J. C.—Fire Clays and Associated Plastic Clays, Kaolins, Feldspars and Fire Sands of New Jersey. *Trans. Amer. Inst. Min. Eng.*, **6**, 177 (1877–78); *Eng. and Min. Jour.*, **25**, 185–200 (1878).

Smock, J. C.—Mining Clay of New Jersey. *Trans. Amer. Inst. Min. Eng.*, **3**, 211 (1874–75).

Smock, J. C.—Two Hundred Clays of New Jersey. *Eng. and Min. Jour.*, New York, March, 23, 1878; March 16, p. 185 (1878).

Twitchell, W. W.—The Geology of the Clay Deposits with Particular Reference to Those of New Jersey. *The Ceramist* **4,** 211–28 (1924).

New Mexico

Blake, W. P.—Alunogen and Bauxite of New Mexico. *Trans. Am. Inst. Min. Eng.*, **24,** 571–3 (1894). (Abs. in *Am. Geologist*, **14,** p. 196.)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 299 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V (cont.)*, p. 1354 (1897).

Foster, W.—A Remarkable Carbonaceous Deposit Near Putnam, New Mexico. *Econ. Geol.*, **8** 360–8 (1913). (Abs. *Inst. Cong. Applied Chem.*, **8** [25], 667 (1913).)

Hayes, C. W.—Bauxite. U. S. Geol. Surv., *16th Ann. Rept. 1894–95, Pt. III*, pp. 549, 550 (1895).

Herrick, C. L.—Miscellaneous Economic Papers. New Mex. Univ., *Bull.* **2** (1900).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 525 (1892).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.*, **6,** 289, 342 (1889). (Adobe.)

Shaler, M. K. and Gardner, J. H.—Clay Deposits of the Western Part of the Durango-Gallup Coal Field of Colorado and New Mex. U. S. Geol. Surv., *Bull.* **315,** 296–302 (1907).

New York

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Catlett, C.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 352 (1904).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** p. 280–1, 288 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept. Pt. V (cont.)*, p. 1354 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150** [9], 214–23 (1900). (Abs. *Rev. Amer. Chem. Research*, **7,** 67–8.)

Dwight, W. B.—A Peculiar Feature of the Clay Beds on the Western Bank of the Hudson, Three Miles North of Newburgh. *Trans. Vassar Bros. Inst.*, 1884–5.

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 287–8, 294–5 (1913).

Fairchild, H. L.—Geology of Thousand Islands Region. N. Y. State Museum (Clay Plains), *Bull.* **145,** 156–9 (1910).

Fisher, H.—Fullers' Earth. *Min. Ind.*, **11,** 241–2.

Hollick, C. A.—On Clay Beds on Staten Island. Nat. Sci. Assoc. Staten Island, *Proc.* **2,** 63 (1890).

Hollick, A.—Minerals from Fire Clay Beds at Green Ridge, Staten Island. *Amer. Nat.*, **35,** 403 (1891).

Hollick, C. A.—Notes on Staten Island Clays. Nat. Sci. Assoc. Staten Island, *Proc.* **3,** 26–7 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892*, pp. 724, 733, 734 (1893).

Hopkins, T. C.—Geology of the Syracuse Quadrangle. N. Y. State Museum (Clay), *Bull.* **171,** 34–7 (1914).

Jones, C. C.—A Geologic and Economic Survey of the Clay Deposits of the Lower Hudson River Valley. *Trans.*

Amer. Inst. Min. Eng., **29**, 40–83 (1900).

Lincoln, D. F.—Report on the Structural and Economic Geology of Seneca County, N. Y. *48th Ann. Rept., N. Y. State Museum, 1894*, **2**, pp. 105–11 (1895). Also in *14th Ann. Rept. State Geologist, 1894*, pp. 105–11 (1895).

Martin, D. S.—A Note on the Colored Clays Recently Exposed at Morrisania, N. Y. *N. Y. Acad. Sci. Trans.*, **9**, 46 (1898).

Mather, W. W.—Geology of New York. Clays. *Geol. of First District, Pt. I*, pp. 141–45, 250–56, 578 (1843).

Merrill, F. J. H.—Note on the Colored Clays at Morrisania, N. Y. *N. Y. Acad. Sci. Trans.*, **9**, 45 (1898).

Merrill, F. J. H.—Origin of the White and Variegated Clays of the North Shore of Long Island, N. Y. *N. Y. Acad. Sci. Trans.*, **12**, 113 (1900).

Merrill, F. J. H.—Clay, Shale, Kaolin, etc. Mineral Resources of N. Y. State. N. Y. State Museum, *Bull.* **3** [15], 494–518 (1895). (Also issued as part of *Museum Rept.*, **45** [1], 363 (1894).)

Nason, F. L.—The Economic Geology of Albany County. Gravels, Sands and Clays. New York State Museum. *47th Ann. Rept. for 1893*, pp. 460–8, 478 (1894).

Nason, F. L.—Economic Geology of Ulster County. Brick Manufacture. New York State Museum, *47th Ann. Rept. for 1893*, pp. 385–87 (1894).

Newland, D. H.—Mineral Resources of the State of New York. N. Y. State Mus., *Bull.* 223–4 (1921). Clay Materials, pp. 47–50.

Ries, H.—Clay Industries of New York. N. Y. State Museum, *Bull.* **3** [12] (1895). (Also part of *State Museum Rept.*)

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, p. 1144 (1897).

Ries, H.—The Clays of the Hudson River Valley. *Trans. N. Y. Acad. Sci.*, **2**, 33–9 (1891).

Ries, H.—Clays of New York: Their Properties and Uses. N. Y. State Museum, *Bull.* **5** [35], 489–944 (1900). (A Revised and Enlarged Edition of Author's Rept. of 1895. Forms part also of 54th Ann. Rept. of Regents, Univ. of State of N. Y., Vol. II (1902).) (Review by J. F. Kemp, *Science* **13**, 946–7 (1901) and in *Jour. Geol.*, **10**, 546.)

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 170–9 (1903).

Ries, H.—Notes on the Clays of New York State and Their Economic Value. *Trans. N. Y. Acad. Sci.*, **12**, 40–7 (1892).

Ries, H.—On the Occurrence of Cretaceous Clays at Northport, Long Island. *School of Mines Quarterly*, **15**, 354–5 (1894).

Ries, H.—Physical tests of the Devonian Shales of New York State to Determine Their Value for the Manufacture of Clay Products. *15th Ann. Rept. State Geologist for 1895*, vol. 1, pp. 675–98.

Ries, H.—Physical Tests of New York Shales. *School of Mines Quarterly*, **19**, 192–4 (1898).

Ries, H.—Quaternary Deposits of the Hudson River Valley between Croton and Albany with Notes on the Brick Clays and the Manufacture of Brick. *N. Y. Geol. Rept. No. 10 for 1890*, pp. 110–55 (1891).

Stoller, J. H.—Glacial Geology of the Cohoes Quadrangle. (Clays.) N. Y. State Museum, *Bull.* **215, 216**, pp. 18, 30–2, 33–5 (1920).

Woodworth, J. B.—Ancient Water Levels of the Champlain and Hudson Valleys. N. Y. State Museum, *Bull.* **84** (1905).

Woodworth, J. B.—Pleistocene Geology of the Mooers Quadrangle. N. Y. State Museum, *Bull.* **83**, 48, 53 (1905).

North Carolina

Bain, H. F.—Review of Clay Deposits and Clay Industry in North Carolina, by H. Ries. *Jour. Geol.*, **6**, 545–7 (1898).

Bayley, W. S.—Kaolin in North Carolina, with a Brief Note on Hydromica. *Econ. Geology*, **15**, 236 (1920).

Bayley, W. S.—The Kaolins of North Carolina. N. Car. Geol. Surv., *Bull.* **29.**

Campbell, M. R. and Kimball, K. K.—The Deep River Coal Field of North Carolina. N. Car. Geol. Surv., *Bull.* **33.**

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 189 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150** [9], 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research*, **7**, 67–8.)

Drane, B. S. and Stuckey, J. L.—The Mineral Industry in North Carolina from 1918–23. N. Car. Geol. Surv., *Economic Paper*, **55.**

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 505 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 505 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources for 1892*, p. 734 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, pp. 616, 617 (1894).

Holmes, J. A.—Notes on the Kaolin and Clay Deposits of North Carolina, *Jour. Elisha Mitchell Soc.*, 12th Year, Pt. 2, pp. 1–10 (1895).

Holmes, J. A.—Notes on the Kaolin and Clay Deposits of North Carolina. *Trans. Am. Inst. Min. Eng.*, **25,** pp. 929–36 (1896). (Abs. *Tech. Quarterly*, **9**, p. 59.)

Holmes, J. A.—Kaolin and Clay of North Carolina. *North Carolina and Its Resources*, pp. 106–7 (1896).

Kerr, W. C. Kaolin, Fire Clay, Etc. Geology of North Carolina, **1,** pp. 296–7 (1875).

Phillips, W. B.—North Carolina Fire Clays. *Eng. and Min. Jour.*, **42,** 326 (1886). (Abs. in *Dingler's Polytech. Jour.*, **263,** p. 110.)

Pratt, J. H.—The Mining Industry of North Carolina During 1900. N. Car. Geol. Surv., *Economic Paper*, **4.**

Pratt, J. H.—Mining Industry of North Carolina during 1902. N. Car. Geol. Surv., *Economic Paper*, **7.**

Pratt, J. H.—Mining Industry of North Carolina during 1903. N. Car. Geol. Surv., *Economic Paper*, **8.**

Pratt, J. H.—Mining Industry of North Carolina during 1904. N. Car. Geol. Surv., *Economic Paper*, **9.**

Pratt, J. H.—Mining Industry in North Carolina during 1905. N. Car. Geol. Surv., *Economic Paper*, **11.**

Pratt, J. H.—Mining Industry of North Carolina during 1906. N. Car. Geol. Surv., *Economic Paper*, **14.**

Pratt, J. H.—Mining Industry in North Carolina during 1907. N. Car. Geol. Surv., *Economic Paper*, **15.**

Pratt, J. H.—Mining Industry of North Carolina during 1908, 1909 and 1910. N. Car. Geol. Surv., *Economic Paper*, **23.**

Pratt, J. H.—Mining Industry of North Carolina during 1911–12. N. Car. Geol. Surv., *Economic Paper*, **34.**

Pratt, J. H.—The Mining Industry of North Carolina during 1913–17. N. Car. Geol. Surv., *Economic Paper*, **49.**

Ries, H.—Clay Deposits and Clay Industry in North Carolina: A Preliminary Rept., *Bull.* **13,** N. C. Geol. Surv. (1897). (Abs., *Tech. Quart.*, **11,** 130; Review by H. F. Bain, *Jour. Geol.*, **6,** 545–7.)

Ries, H.—The Clays of the United States

East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 179–90 (1903).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 18–65, 75–9 (1921).

Watkins, J. H.—White Burning Clays of the Southern Appalachians. *Trans. Amer. Inst. Min. Eng.*, **51,** pp. 489, 498 (1916).

Watts, A. S.—Mining and Treatment of Feldspar and Kaolin in the Southern Appalachian Region. U. S. Bureau Mines, *Bull.* **53;** *Mineral Tech.*, **1,** 170 pp.

North Dakota

Babcock, E. J.—Clays of Economic Value (in N. Dakota). Geol. Surv. N. Dak., *First Rept.*, pp. 27–55 (1901).

Babcock, E. J.—The Coal and Clay Resources of North Dakota. N. Dak. Univ., *Quart. Jour.*, **5** [1], 52–56, Oct. (1914).

Babcock, E. J.—N. Dak. Geol. Surv., *1st Biennial Rept.*, 103 pp. (1901).

Babcock, E. J.—The Uses and Value of North Dakota Clays. N. Dak. State Geol. Surv., *4th Biennial Rept.*, pp. 191–243 (1906).

Babcock, E. J. and Clapp, C. H.—Clay and Its Properties with Special Reference to North Dakota Clays. N. Dak. State Geol. Surv., *4th Biennial Rept.*, pp. 6–91 (1906).

Babcock, E. J. and Clapp, C. H.—Economic Geology of North Dakota Clays. N. Dak. State Geol. Surv., *4th Bien. Rept.*, pp. 95–189 (1906).

Clapp, C. H.—The Clays of North Dakota. *Econ. Geol.*, **2** [6], 551–64 (1907).

Clapp, C. H., Leonard, A. G., Babcock, E. J.—Clays of North Dakota. N. Dak. Geol. Surv., *Biennial Rept.*, 324 pp. (1908).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 524 (1892).

Leonard, A. G.—Stratigraphy of North Dakota Clays. N. Dak. Geol. Surv., *4th Biennial Rept.*, pp. 63–94 (1906).

Leonard, A. G. and Others.—State Geological Survey of North Dakota, *5th Biennial Report* (1908).

Ohio

Andrews, E. R.—Clays of 2nd Geological District. Ohio Geol. Surv., *Rept. Prog. 1869*, pp. 131–2 (1870).

Andrews, E. R.—Report of Labors in the 2nd Geological District during the Year 1870. Ohio Geol. Surv., *Rept. Prog. 1870*, pp. 166, 168–9 (1871).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy Entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceramic Soc.*, **2** [10], 790–3 (1919).

Bleininger, A. V.—Manufacture of Cements. Clays. Ohio Geol. Surv., 4th Ser., *Bull.* **3,** 79–84, 223–6 (1904).

Carney, F.—The Economic Mineral Products of Ohio. Denison Univ., Sci. Lab., *Bull.* **16,** 137–81 (1910).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 283 (1897).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 303 (1913).

Tenneman, N. M.—Geology of Cincinnati and Vicinity. Clays. Ohio Geol. Surv., 4th Ser., *Bull.* **19,** pp. 178–80 (1916).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14,** 301–46 (1912).

Grimsley, G. P.—Some Recent Work on Clays. (Review of Ohio Geol. Surv. Rept. on Clays.) *Science*, **23,** 99–100 (1894).

Hice, R. R.—The Clays of the Upper Ohio and Beaver River Region. *Trans. Amer. Ceram. Soc.*, **7** [2], 1–14 (1905).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 509 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 609 (1894).

Lovejoy, E.—The Clays of Five Mile Creek. *Ohio Min. Jour.*, Whole No. 17, pp. 34–40 (1888).

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2** [5], 374–90 (1919).

Mather, W. W.—First Annual Report on the Geological Survey of the State of Ohio. Clays, p. 10 (1838).

Newberry, J. S.—Sketch of the Structure of the Lower Coal Measures in Northeastern Ohio. Ohio Geol. Surv., *Rept. Prog., 1870*, p. 50–1 (1871).

Newberry, J. S.—Geology of Cuyahoga County. Ohio Geol. Surv., **1** [1], pp. 174–7 (1873).

Newberry, J. S.—Geology of Summit County. Ohio Geol. Surv., **1** [1], pp. 220–1 (1873).

Newberry, J. S.—Geology of Tuscarawas County. Ohio Geol. Surv., 3 pp. 64, 66, 83 (1878).

Newberry, J. S.—Geology of Portage County. Ohio Geol. Surv., **3**, pp. 149–50 (1878).

Newberry, J. S.—Geology of Columbiana County. Ohio Geol. Surv., **3**, p. 131 (1878).

Newberry, J. S.—Geology of Jefferson County. Analyses by Wormley. Ohio Geol. Surv., **3**, p. 780 (1878).

Orton, E.—Report on Geology of Montgomery County. Ohio Geol. Surv., *Rept. Prog. 1869*, pp. 148–9 (1870).

Orton, E.—Geology of Clermont County. Ohio Geol. Surv., **1** [1], pp. 440–6 (1873).

Orton, E., Jr.—The Clay Working Industries of Ohio. Rept. Geol. Surv. Ohio, Vol. VII, Pt. 1. *Econ. Geol.*, pp. 69–254 (1893).

Orton, E., Jr.—The Clays of Ohio and the Industries Established upon Them. Rept. Geol. Surv. Ohio, **5**, 643–721 (1884).

Orton, E., Jr.—The Clays of Ohio, Their Origin, Composition and Varieties. Rept. Geol. Surv. Ohio, Vol. VII, Pt. 1. *Econ. Geol.*, pp. 45–68 (1893).

Phalen, W. C.—Economic Geology of the Kenova Quadrangle, Kentucky, Ohio and West Virginia. U. S. Geol. Surv., *Bull.* **349** (1908).

Read, M. C.—Sketches of the Geology of Geauga and Holmes Counties. Ohio Geol. Surv., *Rept. Prog. 1870*, pp. 482–3 (1871).

Read, M. C.—Geology of Hocking Valley Coal Field. Ohio Geol. Surv., **3** [1], p. 713 (1878).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97*, p. 1145 (1897).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 190–208 (1903).

Ries, H.—Occurrence of Glass-Pot Clays in the U. S. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, p. 133–5.

Stauffer, C. R., Hubbard, G. D. and Bownocker, J. A.—Geology of the Columbiana Quadrangle. Ohio Geol. Surv., 4th Ser., *Bull.* **14**, pp. 117–9 (1916).

Stevenson, J. J.—Geology of Carroll County. Ohio Geol. Surv., **3**, p. 198 (1878).

Stout, W.—The Flint Clay Situation in Ohio. *Jour. Amer. Ceram. Soc.*, **6**, 1153–9 (1923).

Stout, W.—Geology of Muskingum County. Geol. Surv. of Ohio, 4th Ser., *Bull.* **21** (1918).

Stout, W., Stull, R. T., McCaughey, W. J., and Demorest, D. J.—Coal Formation Clays of Ohio. Geol. Surv. of Ohio, 4th Ser., *Bull.* **26.**

Van Horn, F. R.—Clay and Shale Resources in the Vicinity of Cleveland, Ohio. *Trans. Amer. Ceram. Soc.*, **18,** 450–72 (1916).

Wheeler, B.—Clays and Coals of Muskingum County. *Ohio Min. Jour.*, Whole No. 18, pp. 52–4 (1889).

Winchell, N. H.—Geology of Seneca County. Ohio Geol. Surv., **1** [1], pp. 623–4 (1873).

Winchell, N. H.—Geology of Wood County. Ohio Geol. Surv., **2** [1], 386 (1874).

Winchell, N. H.—Geology of Hancock County. Ohio Geol. Surv., **2** [1], 366 (1874).

Wormley, T. G.—Report of Chemical Department. Analyses. Ohio Geol. Surv., *Rept. Prog., 1870,* pp. 445–7 (1871).

Oklahoma

Anon.—Fullers' Earth. *Min. Ind.*, **6,** 254 (1897).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.)*, pp. 1354–6 (1897).

Gould, C. N.—Preliminary Report on the Mineral Resources of Okla. Okla. Geol. Surv., *Bull.* **1,** 84 pp. (1908).

Gould, C. N. and Others.—Brief Chapter on Oklahoma's Minerals. Okla. Geol. Surv., *Bull.* **6,** 33–95 (1910).

Gould, G. C. and Others.—Preliminary Report on the Structural Materials of Oklahoma. Okla. Geol. Soc., *Bull.* **5,** 182 pp. (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 515 (1892).

Shannon, C. W.—Mineral Resources of Oklahoma. Okla. Geol. Surv., *Bull.* **22,** 118–21 (1914).

Snider, L. C.—Preliminary Report on the Clays and Clay Industries of Oklahoma. Okla. Geol. Surv., *Bull.* **7,** 207 pp. (1911). (Abs., *Geol. Centralb.*, **27,** 586 (1911–12).)

Oregon

Darton, N. H.—Structural Materials in Parts of Oregon and Washington. U. S. Geol. Surv., *Bull.* **387,** 33 pp. (1909).

Geijsbeek, S.—The Clay Deposits of Oregon. *Trans. Amer. Ceram. Soc.*, **15,** 644–58 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 528 (1892).

Parks, H. M.—The Economic Geological Resources of Oregon. Ore. Bur. Mines (Ore. Agricultural Coll., Coll. B, Extension Series **5,** No. 2, 120 pp. (1912)).

Stafford, O. F.—The Mineral Resources and Mineral Industry of Oregon for 1903. Ore. Univ., *Bull. Nat. Sci.*, **1** [4], 112 pp. (1904).

Pennsylvania

Anon.—Clays and Shales of Clarion County, Pennsylvania. *Eng. and Mining Jour.*, **84,** 346 (1907).

Anon.—Clay Studies in Pennsylvania. (White Clays of South Mountain by Geo. W. Stose, Clays and Shales of Clarion County by E. F. Lines.) *The Clayworker,* **48,** 249 (1907).

Anon.—Pittsburgh's Clay Production. *The British Clayworker,* **31,** 232 (1922–23).

Anon.—Fire Clay—A Study of the Clays

of Clinton County, Pa. *Mines and Minerals*, **24**, 378–9 (1904).

Ashburner, C. A.—The Geology of McKean County. Pa. Sec. Geol. Surv., *Rept.* **R**, pp. 87, 88 (1880).

Ashburner, C. A.—Report on the Brandywine Smmit Kaolin-bed, Delaware County. Pa. Geol. Surv., *Ann. Rept.*, pp. 593–614 (1885).

Ashley, G. H.—The Fire Brick Materials of Pennsylvania. *Jour. Amer. Ceram. Soc.*, **6** [7], 837–49 (1923).

Ashley, G. H.—Notes on Clays and Shales in Central Pennsylvania. U. S. Geol. Surv., *Bull.* **285**, 442–44 (1906).

Ashley, G. H.—Clay and Shale. Pa. Top. and Geol. Surv., *Rept. 1906–08*, pp. 307–25 (1908).

Ashley, G. H.—Discussion of an Article by Ellis Lovejoy, Entitled "Notes on Fire Clays of the Northern Appalachian Coal Basin." *Jour. Amer. Ceram. Soc.*, **2** [10], 790–3 (1919).

Brown, A. P. and Ehrenfeld, F.—Minerals of Pennsylvania. Pa. Top. and Geol. Surv., *Rept.* **6**, 21–39 (1913).

Butts, C.—Description of the Warren Quadrangle, Pennsylvania-New York. U. S. Geol. Surv., Geol. Atlas, *Warren Folio*, No. **172** (1910).

Butts, C.—Economic Geology of the Kittanning and Rural Valley Quadrangles, Pa. U. S. Geol. Survey, *Bull.* **279**, 198 pp. (1906).

Catlett, C.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228**, 352 (1904).

Catlett, C.—Miscellaneous Analyses. U. S. Geol. Surv., *Bull.* **64**, 51 pp.

Chance, H. M.—A Revision of the Bituminous Coal Measures of Clearfield County. Pa. Sec. Geol. Surv., Rept. **H**, pp. 167–80 (1884).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, 288 (1897).

D'Invilliers, E. V.—Report on the Geology of the Four Counties Union, Snyder, Mifflin and Juniata. Pa. Sec. Geol. Surv., Rept. **F3**, 123, 252 (1888–89).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522**, 316 (1913).

Frazer, P.—Report of Progress in York, Adams and Franklin Counties. Pa. Sec. Geol. Surv., Rept. **CC**, 203, 204 (1875).

Galpin, S. L.—Studies of Flint Clays and Their Associates. *Trans. Amer. Ceram. Soc.*, **14**, 301–46 (1912).

Hall, C. E.—Field Notes in Delaware County. Pa. Sec. Geol. Surv., Rept. **C5**, 47, 48, 76 (1885).

Harden, E. B.—Report on Fire Clay of Wellersburg Coal Basin, Somerset County. Pa. Geol. Surv., *Ann. Rept. 1885*, pp. 239–49 (1886).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 503 (1892).

Hice, R. R.—The Clays of the Upper Ohio and Beaver River Region. *Trans. Amer. Ceram. Soc.*, **7**, 251–62 (1905).

Hice, R. R.—The Fire Clays of Pennsylvania. *Trans. Amer. Ceram. Soc.*, **18**, 401 (1916).

Hice, R. R.—The White Clay Possibilities of Pennsylvania. *Jour. Amer. Ceram. Soc.*, **2** [9], 685–94 (1919).

Hice, R. R.—*Eng. Min. Jour.*, **88**, 105–7. (Abs. in *Jour. Iron and Steel Inst.*, **80** [2], 348 (1909).)

Hopkins, T. C.—Clay and Feldspars of Southeastern Pennsylvania. *Mining Bull.*, **4**, 106–7 (1898).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. I. Clays of Western Penn. (In part.) Appendix to the *Ann. Rept., Pa. State Coll. for 1887*, Off. Doc., No. 21, 83 pp. (1898). Reviewed in *Eng. and Min. Jour.*, p. 243, Aug. 26 (1899).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. II. Clays of Southeastern Pennsylvania. (In part.) *Ann. Rept. Pa. State Coll., 1898–99*, Appendix, **76** pp. (1900).

Hopkins, T. C.—Clays and Clay Industries of Pennsylvania. III. Clays of the Great Valley and South Mountain Areas. *Ann. Rept. Pa. State Col., 1899-1900*, Appendix, 45 pp. (1901). (Reviewed in *Jour. Geol.*, **10,** 545.)

Hopkins, T. C.—Conshohocken Plastic Clays (Pennsylvania). *Bull. Geol. Soc. Amer.*, **10,** 480–4 (1900). (Abs., *Amer. Geol.*, **23,** 102 (1899); *Science* (New Series), **9,** 139 (1899).)

Hopkins, T. C.—Feldspars and Kaolins of Southeastern Penna. *Jour. Franklin Inst.*, **148,** 1–31 (1899).

Hopkins, T. C.—The Fire Clays and Fire Clay Industry at Bolivar, Pa. *The Clayworker*, **31,** 423–6 (1899).

Hopkins, T. C.—The White Clays of Southeastern Pennsylvania. *Eng. and Min. Jour.*, **70,** 131 (1900).

Johnson, S. W.—Clay for Pottery and Kaolin. Pa. Sec. Geol. Surv., *Rept.* **B,** 118–20 (1874).

Lesley, J. P.—The Coal Beds and Fire Clays of the Wellersburg Basin in Sommerset County. (Pa.) Geol. Surv. Pa., *Ann. Rept.*, **1885,** pp. 227–39 (1886).

Lesley, J. P.—Some General Considerations Respecting the Origin and Distribution of the Delaware and Chester Kaolin Deposits. Pa. Geol. Surv., *Ann. Rept.*, pp. 571–91 (1885).

Lines, E. T.—The Clays and Shales in Clarion County, Pennsylvania. U. S. Geol. Surv., *Bull.* **315** (1906). (Abs. in *The Clayworker*, **48,** 267 (1907).)

Lovejoy, E.—Notes on Fire Clays of the Northern Appalachian Coal Basin. *Jour. Amer. Ceram. Soc.*, **2,** 374–90 (1919).

Mansfield, I. F.—Fire Clay, Coals and Titles of the Cannel Coal Tract at Cannelton, Beaver County, Pennsylvania. Beaver Falls, Pa., Tribune Printing Co., *Printers*, 1905 (Priv. Pub.).

McCreath, A. S.—Analyses of Fire Clays. Rept. **M3,** 2nd Geol. Surv., Pa., pp. 95–7 (1881).

McCreath, A. S.—Analyses of Clays and Fire Bricks. *Rept.* **MM,** 2nd Geol. Surv., Pa., pp. 257–79 (1879).

Moore, E. S.—White Clay Deposits in Central Pennsylvania. Pa. Bur. Top. and Geol. Surv., *Bull.* **45** (1922).

Morganroth, L. C.—Pennsylvania Fire Clay. *Bull. Amer. Inst. Min. Eng.*, **110,** 475–81 (1916) (with discussion by D. B. Reger), *Trans.*, **54,** 477–484 (1917).

Morrell, T. T.—Analyses of Fire Clays, in paper by F. Platt. Pa. Geol. Surv., *Rept.* **HH,** 1875, pp. 147, 148, 154 (1877).

Peck, F. B.—White Clay Deposits at Saylorsburg, Monroe County, Pennsylvania. Pa. Bur. Top. and Geol. Surv., *Bull.* **40** (1922). (Abs., *Bull. Geol. Soc. Amer.*, **30,** 96 (1919).)

Phalen, W. C.—Description of the Johnstown Quadrangle, Pennsylvania. U. S. Geol. Surv., Geol. Atlas, *Johnstown Folio*, No. **174** (1910). (Abs., *Jour. Wash. Acad. Sci.*, **2,** 135 (1912).)

Phalen, W. C. and Martin, L.—Clays and Shales of Southwestern Cambria County. U. S. Geol. Surv., *Bull.* **315,** 344–54 (1907). (Abs. in *Jour. Iron and Steel Inst.*, **75** [3], 342 (1907).)

Phalen, W. C. and Martin, L.—Mineral Resources of Johnstown, Pennsylvania and Vicinity. U. S. Geol. Surv., *Bull.* **447,** 113–26 (1911). (Abs., *Jour. Wash. Acad. Sci.*, **2,** 135 (1912).)

Platt, F.—Iron Ores and Fire Clays. 2nd Geol. Surv., Pennsylvania. *Report* **L,** p. 98 et seq. (1876).

Platt, F.—On the Cambria County Fire-Clays, etc. Analyses of Fire Clays. *Rept. of Progress* **HH.** 2nd Geol. Surv. of Penn., pp. 145–9 (1877).

Platt, F. and W. G.—Report of Progress in the Cambria and Sommerset District of the Bituminous Coal-Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **HHH.,** 169, 191, 124, 242 (1876).

Platt, W. G.—Report of Progress in

Armstrong County. Pa. Sec. Geol. Surv., *Rept.* **H5**, pp. 9, 12–5.

Platt, F.—Report of Progress in the Clearfield and Jefferson District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **H**, pp. 128, 129, 177 (1874).

Platt, W. G.—Report of Progress in Indiana County. Pa. Sec. Geol. Surv., *Rept.* **HHHH**, 25, 89, 222 (1877).

Prime, F., Jr.—The Brown Hematite Deposits of the Siluro-Cambrian Limestones. Pa. Sec. Geol. Surv., *Rept.* **DD**, 24, 44, 45 (1878).

Rand, T. D.—Notes on the Geology of Radnor Township, Delaware County and of the Townships Adjacent to it. Pa. Sec. Geol. Surv., *Ann. Rept., Pt. IV*, 1604–1605 (1886).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 208–41 (1903).

Ries, H.—Occurrence of Glass-Pot Clays in the United States. *Mineral Resources of the U. S. for 1901* (1902).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708**, 18, 82–99, 109–16, 135 (1921).

Rogers, H. D., Frazer, P. and Hall, C. E.—The Geology of Chester County. Pa. Sec. Geol. Surv., *Rept.* **C4**, 137, 167, 248, 274, 277, 279, 325, 329 (1883).

Spencer, G.—The Kaolin Beds of Chester County, Pa. and of New Castle County, Delaware. *Proc. Engineers' Club of Philadelphia*, **4**, 302–305 (1885); *Sci. Amer. Supp.*, **31**, p. 1, 2842.

Stevenson, J. J.—Report of Progress in the Fayette and Westmoreland District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **KKK**, 248, 249, 253, 296–9 (1877).

Stevenson, J. J.—Report of Progress in the Green and Washington District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Sec. Geol. Surv., *Rept.* **K**, 88, 389 (1875).

Stone, R. W.—Mineral Resources Elders' Ridge Quadrangle. U. S. Geol. Surv., *Bull.* **256**, 77–8 (1905). (Abs. in *Jour. Iron and Steel Inst.*, **69** [1], 319 (1906).)

Stose, G. W.—White Clays of South Mountain, Pa. U. S. Geol. Surv., *Bull.* **315**, 322–34 (1907). (Abs., *Geol. Centralb.*, **11**, 70 (1908).)

White, I. C.—The Geology of Huntingdon County. Pa. Sec. Geol. Surv., *Rept.* **T3**, 227, 228 (1885).

White, I. C.—The Geology of Pike and Monroe Counties. Pa. Sec. Geol. Surv., *Rept.* **66**, 171 (1881).

White, I. C.—Report of Progress in the Beaver River District of the Bituminous Coal Fields of Western Pennsylvania. Pa. Geol. Surv., *Rept.* **Q**, 13, 46, 57–9, 63, 96, 159, 161, 183, 190, 192–3, 195–6, 215, 224, 265 (1875).

Woolsey, L. H.—Clays of the Ohio Valley in Pennsylvania. U. S. Geol. Surv., *Bull.* **225**, Series A, *Econ. Geol.*, **33**, 463–81. (List of Survey publications on Clays and Fullers' Earth, p. 481.)

Woolsey, L. H.—Economic Geology of the Beaver Quadrangle, Pa. (Southern Beaver and Northwestern Alleghany Counties.) U. S. Geol. Surv., *Bull.* **286**, 132 pp. (1906).

Wright, G. F.—The Age of the Philadelphia Brick Clay. *Science*, New Ser., **3**, 242–3 (1896).

Rhode Island

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the United States, 1891*, p. 502 (1892).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11**, 241 (1903).

Shaler, N. S., Woodworth, J. B. and Marbut, C. F.—The Glacial Brick Clays of Rhode Island and Southeastern Massachusetts. U. S. Geol. Surv., *17th Ann. Rept.*, pp. 951–1004 (1896).

South Carolina

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** p. 290 (1897).

Hammond, H.—Kaolin. South Carolina, Resources and Population. pp. 120, 170, 608 (1883).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 506 (1892).

Lieber, O. M.—Clays. *1st Ann. Rept. Survey South Carolina,* pp. 97–9 (1858).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 241–3 (1903).

Ries, H.—The Occurrence of High-Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.,* **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 79–82, 164–94, 211–22 (1921).

Sloan, E.—Catalogue of the Mineral Localities of South Carolina. S. Car. Geol. Surv., *Bull.* **2** [4] (1908).

Sloan, E.—Geology and Mineral Resources of S. Carolina. S. Car. State Dept. Agr., *Handbook of South Carolina,* pp. 77–145 (1907).

Sloan, E.—A Preliminary Report on the Clays of South Carolina. South Carolina Geol. Surv., *Bull.* **1,** 171 pp. (1904).

Watkins, J. H.—White-Burning Clays of the Southern Appalachian States. *Trans. Amer. Inst. Min. Eng.,* 51–492 (1915).

Weigel, W. M.—The White Clay Industry in the Vicinity of Langley, South Carolina. Bur. Mines, *Repts. Investigations,* No. **2322,** 6 pp. (1922).

South Dakota

Anon.—Fullers' Earth. *Min. Ind.,* **6,** 254 (1897).

Anon.—Fullers' Earth. *Min. Ind.,* **9,** 296–8 (1900).

Day, D. T.—Fullers' Earth. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.),* pp. 1351–3 (1897).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst., Rept.* **CL,** 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research,* **7,** 67–8.)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 329 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 524 (1892).

Ries, H.—The Fullers' Earth of South Dakota. *Trans. Amer. Inst. Min. Eng.,* **27,** 333–5 (1897).

Stanton, T. W.—A Cretaceous Volcanic Ash Bed on the Great Plains in South Dakota. *Jour. Wash. Acad. Sci.,* **7,** 80–1 (1917).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 363 (1904).

Todd, J. E.—Preliminary Report on the Geology of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **1** (1894).

Todd, J. E.—The Clay and Stone Resources of South Dakota. *Eng. and Min. Jour.,* **66,** 371 (1898).

Todd, J. E.—First and Second Biennial Reports on the Geology of South Dakota with Accompanying Papers. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **2,** 131 pp. (1898).

Todd, J. E.—Mineral Building Materials, Fuels and Waters of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **3,** General, pp. 98, 101; Brick, pp. 104–6; China, p. 102; Fire, pp. 102–4; Fullers' Earth, pp. 107–8; Potters, p. 104 (1902).

Todd, J. E.—Mineral Resources of South Dakota. Fullers' Earth. S. Dakota Geol. Surv., *Bull.* **3,** 107–8 (1902).

Visher, S. S.—The Geography of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **8,** 21 (1918).

Visher, S. S.—Preliminary Report on the Geology, Geography and Biology of South-Central South Dakota. S. Dak. Geol and Nat. Hist. Surv., *Bull.* **5,** 60 (1912).

Ward, F.—Geology of a Portion of the Badlands. S. Dak. Geol. and Nat. Hist. Surv., *Bull.* **11,** 51–3 (1922).

Ward, F.—The Natural Resources of South Dakota. S. Dak. Geol. and Nat. Hist. Surv., *Circ.* **16,** 18–9 (1924).

Wherry, E. T.—Clay Derived from Volcanic Dust in the Pierre in S. Dakota. *Jour. Wash. Acad. Sci.*, **7** [19], 576–83 (1917).

Tennessee

Ashley, G. H.—Aluminum and Bauxite Mining in Tennessee. *Min. World,* **36,** 557–8 (1912).

Ashley, G. H.—Bauxite Mining in Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **1** [6], 211–19 (1911).

Ashley, G. H.—Bauxite Mining in the State of Tennessee. *Min. Science,* **115,** 8–9 (1912).

Ashley, G. H.—The Clays of Tennessee. *Min. and Sci. Press,* **101,** 713 (1910).

Ashley, G. H.—Outline Introduction to the Mineral Resources of Tennessee. Tenn. Geol. Surv., *Bull.* **2A,** 1–65 (1910).

Crider, A. F.—Clays of Western Kentucky and Tennessee. U. S. Geol. Surv., *Bull.* **285,** 417–27 (1906).

Currey, R. P.—A Sketch of the Geology of Tennessee. Alum Shales, p. 30–1 (1857).

Eckel, E. C.—Stoneware and Brick Clays of Western Tennessee and Northwestern Mississippi. U. S. Geol. Surv., *Bull.* **213,** 382–91 (1903). (Abs., *Geol. Centralb.*, **5,** 57 (1904).)

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 516 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 609, 610 (1894).

Kirkpatrick, F. A.—Tests on the Clays of Henry County. Tenn. Geol. Surv., *Resources of Tenn.*, **2** [11], 18 (1912).

Miser, H. D.—Mineral Resources of the Waynesboro Quadrangle Tennessee. Tenn. Geol. Surv., *Bull.* **26,** 142 (1921).

Nelson, W. A.—Appalachian Bauxite Deposits. *Bull. Geol. Soc. Amer.*, **34,** 525–40 (1923).

Nelson, W. A.—Clay Deposits of West Tennessee. State of Tennessee, *Bull. Geol. Surv.*, **5,** 18 (1911).

Nelson, W. A.—Great Possibilities in Tableware Manufacturing. *Bull. Tenn. Geol. Surv.*, **23,** 3 (1920).

Nelson, W. A.—Lignite and Lignitic Clays in West Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **2** [4], 4 (1912).

Nelson, W. A.—Mid-Ordovicic Volcanic Ash in Tennessee (Bentonite). *Pan-Amer. Geologist,* **37,** 251 (1922).

Nelson, W. A.—Mineral Products along the Tennessee Central Railroad. Tenn. Geol. Surv., *Resources of Tenn.*, **3** [3] (1913).

Nelson, W. A.—Notes on a Volcanic Ash Bed in the Ordovician of Middle

Tennessee. Tenn. Geol. Surv., *Bull.* **25,** 3 (1920).

Nelson, W. A.—Tennessee Ball Clay and Its Manufacturing Possibilities. *Manufact. Rec.*, p. 3, Feb. 17 (1921).

Nelson, W. A.—Volcanic Ash Bed in Ordovician of Tennessee, Kentucky and Alabama. *Bull. Geol. Soc. Amer.*, **33,** 605–16 (1922).

Parmelee, C. W.—Characteristic Properties of Ball and Plastic Refractory Bond Clays. Tenn. Geol. Surv., *Resources of Tenn.*, **9** [2], 191 pp. (1919).

Purdue, A. H.—Bauxite in Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **4** [2], 87–91 (1914).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 243–8 (1903).

Ries, H.—The Occurrence of High Grade American Clays and the Possibilities of Their Further Development. *Jour. Amer. Ceram. Soc.*, **1** [7], 446–67 (1918).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 222–3, 225–30, 236, 260–75 (1921).

Schaller, W. T.—Analyses of Tennessee Clays. U. S. Geol. Surv., *Bull. Analyses of Rocks, 1880 to 1903,* **228,** p. 358 (1904).

Schroeder, R. A. and Parmelee, C. W.—Ball Clays of West Tennessee. Tenn. Geol. Surv., *Resources of Tenn.*, **9** [2], 81–180, No. 2 (1919).

Sortwell, H. H.—The Properties of Some Ball Clays. *The Ceramist,* **2** [1], 5–15 (1922).

Watkins, J. H.—Bauxite near Elizabethtown, Tenn. *Eng. Min. Jour.*, **95,** 604–5 (1913).

Watkins, J. H.—White Burning Clays of the Southern Appalachians. *Trans. Amer. Inst. Min. Engrs.*, **51,** 496 (1916).

Texas

Deussen, A.—Notes on Some Clays from Texas. U. S. Geol. Surv., *Bull.* **470,** 302–51 (1911).

Drake, N. F. and Thompson, R. A.—The Colorado Coal Field of Texas. Tex. Geol. Surv., *4th Ann. Rept.*, p. 357 (1893).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 345 (1913).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* pp. 518–22 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* pp. 724, 735–7 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* p. 610 (1894).

Kennedy, W.—Texas Clays and Their Origin. *Science,* **22,** 297–300 (1893).

Kruson, J. H.—Refractory Clays of Texas. *Jour. Amer. Ceram. Soc.*, **5,** 643–5 (1922).

Mayer, A.—Notes on Texas Kaolin. *Trans. Amer. Ceram. Soc.*, **10,** 91 (1908).

Merrill, G. P.—Non-Metallic Minerals, 2d Ed., 229 (1910). Halloysite.

Richardson, G. B.—Portland Cement Materials near El Paso, Tex. U. S. Geol. Surv., *Bull.* **340,** pp. 411–4 (1908).

Ries, H.—The Clays of Texas. *Trans. Amer. Inst. Min. Eng.*, **37,** 520–58 (1907).

Ries, H.—The Clays of Texas. *Bull. Univ. of Tex.*, **102,** 316 pp. (1908). (Abs., *Geol. Centralb.*, **12,** 549 (1909).

Ries, H.—A Peculiar Type of Clay. *Amer. Jour. Sci.*, **44** [4], 316–8 (1917).

Taff, J. A. and Leverett, S.—The Cretaceous Area North of the Colorado River. Tex. Geol. Surv., *4th Ann. Rept.* p. 241 (1893).

Wilson, J. M.—Potteries, Clays, Etc., in Western Texas. Tex. Almanac, pp. 144–6 (1870).

Utah

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 299 (1897).

Greaves-Walker, A. F.—The Commercial Clays of Utah. *Trans. Amer. Ceram. Soc.*, **13,** 277 (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* 526 (1892).

Russell, I. C.—Subaerial Deposits of North America. *Geol. Mag.*, **6,** 289, 342 (1889). Adobe Clay.

Vermont

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 277–9 (1897).

Dewey, C.—Porcelain Clay. (Pownal, Vt.) *Amer. Jour. Sci.*, **12,** 298–9 (1827).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 502 (1892).

Hunt, T. S.—Analyses of Clays. *3rd Ann. Rept. Geology, Vermont,* p. 8 (1848).

Hunt, T. S.—Analyses of Clays. *4th Ann. Rept. Geology, Vermont,* p. 8 (1848).

Nevius, J. N.—Kaolin in Vermont. *Eng. and Min. Jour.*, **64,** 189 (1897).

Perkins, G. H.—Mineral Resources of the State. Kaolin and Fire Clay. *Rept. Vt. State Geologist, 1903,* p. 52 (1904).

Perkins, G. H.—Mineral Resources of the State. Clays at Rutland. *Rept. Vt. State Geologist, 1907–8,* p. 46 (1908).

Perkins, G. H.—Mineral Resources of Vermont. Bennington clay. *Rept. Vt. State Geologist, 1911–12,* p. 266 (1912).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 132 (1903).

Woodworth, J. B.—The Brandon Clays. *Rept. Vt. State Geologist, 1903–4,* p. 166 (1904).

Virginia

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 289 (1897).

Darton, N. H.—Economic Geology of Richmond, Va., and Vicinity. U. S. Geol. Surv., *Bull.* **483,** 48 pp. (1911).

Day, D. T.—The Occurrence of Fullers' Earth in the United States. *Jour. Franklin Inst.*, **150,** 214–23 (1900). (Abs. in *Rev. Amer. Chem. Research,* **7,** 67–68.)

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **243,** 317, 320, 322 (1905).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 505 (1892).

Heyward, B. H.—A Zinc-Bearing Clay from Virginia. *Chem. News,* **60,** 207. (Abs., *Jour. Chem. Soc.* (London), **42,** 24 (1882).)

Heinrich, O. J.—The Mesozoic Formation in Virginia. (Ceramic Clays.) *Trans. Amer. Inst. Min. Eng.*, **6,** 273.

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893,* pp. 610, 611 (1894).

Merrill, G. P.—Residual Clay of Limestone from Staunton, Augusta County, Va. Analyses. U. S. Geol. Surv., *Bull.* **150,** 384–85 (1898). (See also *Trans. Amer. Soc. Civ. Eng.*, **24,** 552 (1893).)

Moxham, E. C.—Zinc Smelting at the Bertha Works, Virginia. (Analyses of Fire Clay.) *Eng. and Min. Jour.*, **56,** 544 (1893).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 248–52 (1903).

Ries, H.—Clays of the Virginia Coastal Plain. Va. Geol. Surv., *Bull.* **2,** 25–176 (1906).

Ries, H., Bayley, W. S. and Others.—High-Grade Clays of the Eastern United States. U. S. Geol. Surv., *Bull.* **708,** 18, 99–104 (1921).

Ries, H. and Somers, R. E.—The Clays of the Piedmond Province, Va. Va. Geol. Surv., *Bull.* **13,** 86 pp. (1917).

Ries, H. and Somers, R. E.—The Clays and Shales of Virginia West of the Blue Ridge. Va. Geol. Surv., *Bull.* **20,** 118 pp. (1920).

Steiger, G.—Analyses of Rocks, 1880 to 1903. U. S. Geol. Surv., *Bull.* **228,** 354 (1904).

Valentine, E. R.—On a Decomposition Product of Allanite, a Variety of Kaolinite, from Nelson County, Va. *Am. Chem. Jour.*, **7,** 178–80 (1885–86).

Watson, T. L.—Economic Products of the Virginia Coastal Plain. Va. Geol. Surv., *Bull.* **4,** 223–63 (1912).

Washington

Anon.—New Kaolin Deposits Formed in the State of Washington. *The Clay-worker*, **78,** 127 (1922).

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 301 (1897).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 360–4 (1913).

Geijsbeek, S.—The Clay Deposits of Washington. *Trans. Amer. Ceram. Soc.*, **13,** 751–64 (1911).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* pp. 525, 526 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892,* p. 738 (1893).

Hillebrand, W. T.—Analyses of Rocks, 1880–1903. U. S. Geol. Surv., *Bull.* **228,** 370 (1904).

Landes, H.—The Clay Deposits of Washington. Contributions to Economic Geology, 1904. U. S. Geol. Surv., *Bull.* **260,** 550–8 (1905).

Landes, H.—The Non-Metalliferous Resources of Washington, except Coal. (Clay Materials.) Washington Geol. Surv., *Annual Rept. for 1901,* **1,** 173–4 (1902).

Shedd, S.—The Clays of the State of Washington, Their Geology, Mineralogy and Technology. 341 pp. (1910).

Wilson, H., Bennett, A. L. and Heath, F. T.—Preliminary Report on the Residual Kaolin and Feldspar in the Pacific Northwest. *Jour. Amer. Ceram. Soc.*, **6,** 475–90 (1923).

Wilson, H.—The Clays and Shales of Washington, Their Technology and Uses. Univ. Wash., Eng. Expt. Sta., *Bull.* **18** (1923).

West Virginia

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **243,** 328 (1905). (A later edition, *Bull.* **522.**)

Grimsley, G. P.—Clays, Limestones and Cements. W. Va. Geol. Surv., **3,** 565 pp. (1907). (Abs., *Eng. and Min. Jour.*, **81,** 1058 (1906).)

Grimsley, G. P.—Report on Ohio, Brooke and Hancock Counties. W. Va. Geol. Surv., 378 pp. (1907).

Grimsley, G. P.—Report on Pleasants, Wood and Ritchie Counties. W. Va. Geol. Surv., 352 pp. (1910).

Hennen, R. V.—Report on Doddridge and Harrison Counties. W. Va. Geol. Surv., 712 pp. (1912).

Hennen, R. V.—Report on Marshall, Wetzel and Tyler Counties. W. Va. Geol. Surv., 654 pp. (1909).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, p. 515 (1892).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1892*, p. 724 (1893).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources, 1893*, p. 611 (1894).

Krebs, C. E.—Report on Jackson, Mason and Putnam Counties. W. Va. Geol. Surv., 387 pp. (1911).

Phalen, W. C.—Economic Geology of the Kenova Quadrangle, Kentucky, Ohio and West Virginia. U. S. Geol. Surv., *Bull.* **349,** 158 pp. (1908).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 252–62 (1903).

Wisconsin

Alden, W. C.—Description of the Milwaukee Quadrangle, Wis. U. S. Geol. Surv., Geol. Atlas, *Milwaukee Folio*, **140,** 12 pp. (1906).

Berkey, Charles P.—Laminated Interglacial Clays of Grantsburg, Wis. *Jour. Geol.*, **13** [1], 35–45 (1905).

Buckley, E. R.—The Clays and Clay Industries of Wisconsin. Wis. Geol. and Nat. Hist. Surv., *Bull.* **7,** Pt. 1, Econ. Ser., No. 4 (1901).

Chamberlin, T. C.—Color of Milwaukee Bricks and Analyses of Clays. *Geol. of Wis.*, **1,** 668–73 (1883), **2,** 235–9 (1877).

Chamberlin, T. C. and Salisbury, R. D.—The Driftless Area of the Upper Mississippi. *6th Annual Rept. Geol. Surv. for Year, 1884–85*, pp. 199–322 (1885). (Analyses of Residual and Glacial Clays, p. 250.)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 283, 294 (1897).

Daniels, E.—Clay in Wisconsin. *Mining Mag.*, **2,** 346 (1854).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891*, 522, 523 (1892).

Irving, R. D.—The Geology of Central Wisconsin. Geol. of Wisconsin, **2,** 465–524 (1877).

Irving, R. D.—Kaolin in Wisconsin. *Trans. Wis. Acad. Sci.*, **3,** pp. 3–30 (1875–76). Republished without credit in *The Brickmaker* for Sept. 15 and Oct. 1, 1890; Long extracts from it in same publication for Oct., 1892.

Irving, R. D.—The Mineral Resources of Wisconsin. (Brick, Clays and Kaolin.) *Trans. Am. Inst. Min. Eng.*, **8,** 502–6 (1879–80).

Ries, H.—The Clays of the United States East of the Mississippi River. U. S. Geol. Surv., *Prof. Paper* **11,** 262–73 (1903).

Ries, H.—The Clays of Wisconsin and Their Uses. Wis. Geol. and Nat. Hist. Surv., *Bull.* **15,** Econ. Series, No. 10 (1906).

Riggs, R. B.—Analyses of Four Residuary Clays from Wisconsin. U. S. Geol. Surv., *Bull.* **27,** 67, 68 (1886).

Salisbury, R. D.—Chemical Analyses of Clays. *Geol. of Wisconsin*, **1,** 306 (1883).

Sweet, E. T.—Milwaukee Clays and Bricks. (Analyses of Clays.) *Amer. Jour. Sci.*, 3rd Ser., **24,** 154 (1882).

Also Geology of Wisconsin, **1,** 669 (1873–9).

Weidman, S.—The Geology of North Central Wisconsin. Wis. Geol. and Nat. Hist. Surv., *Bull.* **14,** Sci. Ser., No. 4 (1907).

Wyoming

Bastin, E. S.—Note on the Baked Clays and Natural Slags in Eastern Wyoming. *Jour. Geol.*, **13,** 408–12 (1905). (Abs., *Geol. Centralb.*, **7,** 689 (1905–06).)

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148,** 299 (1897).

Darton, N. H.—Bentonite in Wyoming. U. S. Geol. Surv., Geol. Atlas, *Folio,* **107,** 5, 9 (1904).

Darton, N. H. and Siebenthal, C. E.—Geology and Mineral Resources of Laramine Basin, Wyo. U. S. Geol. Surv., *Bull.* **364,** 34, 58–61 (1909).

Eckel, E. C.—Cement Materials and Industry of the United States. U. S. Geol. Surv., *Bull.* **522,** 374 (1913).

Fisher, C. A.—The Bentonite Deposits of Wyoming. U. S. Geol. Surv., *Bull.* **260,** 559–63 (1905). (Abs., *Geol. Centralb.*, **8,** 34 (1906).)

Fisher, C. A.—Geology of Bighorn Basin, Wyo. U. S. Geol. Surv., *Prof. Paper* **53,** 29, 56–8 (1906).

Fisher, C. A.—Mineral Resources of the Bighorn Basin. U. S. Geol. Surv., *Bull.* **285,** 311–5 (1906).

Hill, R. T.—Clay Materials of the United States. U. S. Geol. Surv., *Mineral Resources of the U. S., 1891,* p. 524 (1892).

Knight, W. C.—Bentonite. *Eng. Min. Jour.*, **66,** 491 (1898).

Knight, W. C.—The Building Stones and Clays of Wyoming. *Eng. Min. Jour.*, **66,** 546–7 (1898).

Knight, W. C.—"Mineral Soap." (Analyses of Clays from Wyoming.) *Eng. Min. Jour.*, **63,** 600–1 (1897).

Ohly, J.—The Occurrence of Bauxite in Colorado and Wyoming, and Its Utilization. (1st Part.) *Min. Reporter,* Denver, Sept. 12 (1901).

Ries, H.—The Clay-Working Industry in 1896. U. S. Geol. Surv., *18th Ann. Rept., Pt. V (cont.), 1896–97,* pp. 1145, 1146 (1897).

Siebenthal, C. E.—Bentonite of the Laramine Basin, Wyo. U. S. Geol. Surv., *Bull.* **285,** 445–7.

Wherry, E. T.—Bentonite in Wyoming. U. S. Geol. Surv., *Bull.* **624,** 342 (1917).

CANADA

Alberta

Allan, J. A.—Bentonite. Sci. Ind. Research Council of Alberta, Min. Res. *1st Ann. Rept., 1919,* p. 41; *2nd Ann. Rept., 1920,* p. 36; *3rd Ann. Rept., 1921,* pp. 21, 35–9, 43, 58, 65; *4th Ann. Rept., 1922, Pt. I,* pp. 62–4.

Ella, S. C.—Clay Deposits near Mac Murray, Alberta. Canada Dept. Mines., *Bull.* **10,** 15 pp. (1915).

Hoffmann, G. C.—Soap Clay. Can. Geol. Surv., *Rept. of Progress, 1873–4,* 64.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911,* p. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Canada Geol. Surv., *Memoir,* **66** (1915).

Keele, J.—Notes on Bentonite. Can. Mines Branch, *Sum. Rept., 1918,* pp. 159–61.

Reat, S. C.—Ceramic Resources of Alberta. *Commerce Reports.* (Abs. in *The Clayworker,* **64,** 514 (1915).)

Ries, H.—Clay and Shale Deposits of the

Western Provinces of Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Trans.*, **14**, 351–94 (1911). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, p. 225–9 (1912).

Ries, H.—Clay Investigations in Western Canada. Can. Geol. Surv., *Sum. Report, 1912*, 229–33 (1914).

Ries, H.—Clay and Shale Deposits of the Western Provinces. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces. Part IV. Can. Geol. Surv., *Memoir*, **65** (1915).

Ries, H.—Clays of British Columbia and Alberta. Can. Geol. Surv., *Sum. Rept., 1913*, pp. 284–7 (1914).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Surv., *Memoir*, **25** (1913).

Selwyn, A. R. C.—Bentonite. Can. Geol. Surv., *Rept. of Progress, 1873–74*, p. 38.

Tyrrell, J. B.—Report on a Part of Northern Alberta, and Portions of Adjacent Districts of Assiniboia and Saskatchewan, Embracing the Country Lying South of the North Saskatchewan River and North of Lat. 51°6′, and between Long. 110° and 115°15′ W. Can. Geol. Surv., *Ann. Rept.*, **2**, 151E (1887).

Spence, H. S.—Bentonite. Can. Mines Branch, No. 626 (1924).

British Columbia

Anon.—Kaolin in British Columbia. *Mine, Quarry and Derrick*, Apr. 14, p. 186 (1915).

Anon.—Kaolin Deposits in British Columbia. *Pottery Gaz.*, **47**, 1702 (1922).

Anon.—Clay in British Columbia. *British Clayworker*, **31**, 360 (1922–23).

Anon.—Canadian Kaolin. *Raw Mat. Rev.*, **2**, 97 (1923).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 133A (1903).

Brummell, H. P. H.—Division of Mineral Statistics and Mines Annual Report for 1892. Can. Geol. Surv., *Ann. Rept.*, **6**, 45S (1894).

Camsell, C.—Coast Range, Lytton to Vancouver; Fire Clay Deposits at Clayburn, B. C. 12th Int. Geol. Cong., *Can. Guide Book*, No. **8**, 256–74, 343–9 (1913).

Camsell, C.—Note on the Occurrence of Diatomaceous Earth, Clay and Magnesite along the Route of the Pacific Great Eastern Railway. Can. Geol. Surv., *Sum. Rept., 1917, Pt. B.*, pp. 25–8 (1918).

Clapp, C. H.—Sooke and Duncan Map Areas, Vancouver Island. Can. Geol. Surv., *Mem.*, **96**, 397–9 (1917).

Dawson, G. M.—Summary Report on the Operations of the Geological Survey for the Year 1894. Can. Geol. Surv., *Ann. Rept.*, **7**, 16A (1895).

Dawson, G. M.—Report on the Area of the Kamloops Map-Sheet British Columbia. Can. Geol. Surv., *Ann. Rept.*, **7**, 80B, 346B (1895).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **6**, 91R (1895); **12**, 61R (1901); **13**, 61R (1903).

Ingall, E. D.—Section of Mines Annual Report for 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 76S (1903).

Johnston, W. A.—Geology of the Frazer River Delta Map Area. Can. Geol.

Surv., *Mem.*, **135**, 74–5 (1923).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66** (1915).

Keele, J.—Refractory Materials of Canada. Can. Mines. Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1918*, p. 153.

Reinecke, L.—Undeveloped Mineral Resources of the Clinton District, B. C. *Trans. Can. Min. Inst.*, **22**, 343 (1919).

Reinecke, L.—Mineral Deposits between Lillooet and Prince George, B. C. Can. Geol. Surv., *Memoir*, **118**, 129 pp. (1920).

Ries, H.—Clay and Shale Deposits of the Western Provinces of Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. *Trans. Can. Min. Inst.*, **14**, 351 (1911).

Ries, H.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H.—Clay Investigations in Western Canada. Can. Geol. Surv., *Sum. Rept., 1912*, pp. 229–33 (1914).

Ries, H.—Clays of British Columbia and Alberta. Can. Geol. Surv., *Sum. Rept., 1913*, pp. 284–7 (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H.—The Clay and Shale Deposits of the Western Provinces. Part IV. Canada Geol. Surv., *Memoir*, **65** (1915).

Ries, H. and Keele, J.—Preliminary Report of the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Survey, *Memoir*, **25** (1913).

Robertson, W. F.—Fire Brick Manufactured at Clayburn, British Columbia. Minister of Mines, Brit. Col., *Annual Rept.*, **28** (1921).

Spence, H. S.—An Addition to the Mineral Resources of Canada. Bentonite or Colloidal Clay. *Jour. Inst. Petrol. Tech.*, **10**, 707–9 (1924).

Spence, H. S.—Bentonite. Can. Mines Branch, *Rept.*, **626** (1924).

Manitoba

Bell, R.—Summary Report on the Operations of the Geological Survey for the Year 1903. Can. Geol. Surv., *Ann. Rept.*, **15**, 187–8AA (1904).

Davis, N. B.—Tests of Clay and Shales from Pembina Mountains in South Manitoba. Can. Mines Branch, *Rept.*, p. 117 (1916).

Dowling, D. B.—Report on the Geology of the West Shore and Islands of Lake Winnipeg. Can. Geol. Surv., *Ann. Rept.*, **11**, 11F (1900).

Harrington, B. J.—Notes of Samples of Brick Clay from Ft. Garry. Can. Geol. Surv., *Rept. Prog., 1873–74*, pp. 296–300 (1873).

Hoffmann, G. C.—Tests of Brick Clay from Souris City. Geol. Surv. of Can. *Prog. Rept., 1880–82*, pp. 2–4 (1883).

Johnston, W. A.—Semi-Refractory Clay and Pure Quartz Sand of Swan River Valley (Manitoba). Can. Geol. Surv., *Sum. Rept., 1917, Pt. II*, pp. 37–9 (1918).

Keele, J.—Clay Resources of the Western Provinces. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 181–2 (1911).

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66** (1915).

Keele, J.—Refractory Materials in Can-

ada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

McConnell, R. G.—Report on the Cypress Hills Wood Mountain and Adjacent Country Embracing That Portion of the District of Assiniboia Lying between the International Boundary and the 51st Parallel and Extending from Long. 106° to Long. 110° 50′. Can. Geol. Surv., *Ann. Rept.*, **1**, 77–8C (1885).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Trans.*, **14**, 351–94 (1911–12). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H.—Clay and Shale Deposits of the Western Provinces. Part III. Can. Geol. Surv., *Memoir*, **47** (1914).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 231 pp. (1912).

Ries, H. and Keele, J.—Report of the Clay and Shale Deposits of the Western Provinces. Part II. Can. Geol. Surv., *Memoir*, **25** (1913).

Upham, W.—Report on Exploration of the Glacial Lake Agassiz in Manitoba. Can. Geol. Surv., *Ann. Rept.*, **4**, 109–10E (1890).

Wells, J. W.—Preliminary Report on the Industrial Value of the Clays and Shales of Manitoba. Dept. of Interior, Mines Branch, 68 pp. (1905). (Abs., *Geol. Centralb.*, **7**, 588 (1905–06).)

New Brunswick

Bailey, L. W.—The Mineral Resources of the Province of New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **10**, 115–8M (1898).

Bailey, L. W.—Report on Explorations in Portions of the Counties of Victoria Northumberland and Restigouche, New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **2**, 19N (1887).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15**, 381A (1903).

Chalmers, R.—Preliminary Report on the Surface Geology of New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **16**, 58GG (1885).

Chalmers, R.—Report on the Surface Geology of Northern New Brunswick and Southeastern Quebec. Can. Geol. Surv., *Ann. Rept.*, **2**, 38M (1887).

Chalmers, R.—Report on the Surface Geology of Northeastern New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **3**, 32N (1888).

Chalmers, R.—Report on the Surface Geology of Southern New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **4**, 91N (1890).

Chalmers, R.—Report on the Surface Geology of Eastern New Brunswick, Northwestern Nova Scotia and a Portion of Prince Edward Island. Can. Geol. Surv., *Ann. Rept.*, **7**, 147M (1895).

Chalmers, R.—Report on the Surface Geology Shown on the Frederickton and Andover Quarter-Sheet Maps, New Brunswick. Can. Geol. Surv., *Ann. Rept.*, **12**, 41M (1901).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **13**, 59R (1903).

Ingall, E. D.—Division of Mineral Statistics and Mines Annual Report for

1890. Can. Geol. Surv., *Ann. Rept.*, **5**, 12S (1891).

Keele, J.—Notes on Tests of Clay Samples. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 233–4 (1912).

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of New Brunswick, Can. Geol., *Surv. Memoir*, **44** (1914).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Ries, H. and Keele, J.—The Clay and Shale Deposits of Nova Scotia and Portions of New Brunswick. Geol. Surv. of Can., *Memoir*, **16**, 164, (1911). (Abs., *Geol. Centralb.*, **17**, 636 (1911–12).)

Selwyn, A. R. C.—Summary Report of the Operations of the Geological Survey for the Years 1884 and 1885. Can. Geol. Surv., *Ann. Rept.*, **1**, 20A (1886); **4**, 42A (1890); **5**, 56A (1893).

Northwestern Territory

Dawson, G. M.—Notes to Accompany a Geological Map of the Northern Portion of the Dominion of Canada, East of the Rocky Mountains. Can. Geol. Surv., *Ann. Rept.*, **2**, 18R (1887).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **6**, 88–9R (1895); **12**, 60–1R (1901); **13**, 61R (1903).

Ingall, E. D.—Division of Mineral Statistics and Mines, Annual Report for 1892. Can. Geol. Surv., *Ann. Rept.*, **6**, 78S (1894).

McConnel, J.—Yukon and Mackenzie Basins, N. W. T. Can. Geol. Surv., *Ann. Rept.*, **6**, 99D (1888–89).

Nova Scotia

Anon.—Fire Clay in Nova Scotia. *British Clayworker*, **14**, 227 (1905–06).

Bailey, L. W.—Report on the Geology of Southwest Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **9**, 20M, 150M (1898).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Year 1903. Can. Geol. Surv., *Ann. Rept.*, **15**, 163AA, 186AA (1904).

Chalmers, R.—Report on the Surface Geology of Eastern New Brunswick, Northwestern Nova Scotia and a Portion of Prince Edward Island. Can. Geol. Surv., *Ann. Rept.*, **7**, 147M (1895).

Dawson, G. M.—Summary Report on the Operations of the Geological Survey for Different Years as Follows: Can. Geol. Surv., *Ann. Rept.*, **7**, 95A (1895); **8**, 110A (1896); **9**, 93A, 97A (1897).

Faribault, E. R.—Clays in Lunenburg County, Nova Scotia. Can. Geol. Surv., *Sum. Rept., 1912*, p. 383 (1914).

Fletcher, H.—Report on Geological Surveys and Explorations in the Counties of Pictou and Colchester, Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **5**, 156P, 189–90P (1892).

Fletcher, H. and Faribault, E. R.—Report on Geological Surveys and Explorations in the Counties of Guysborough, Antigonish, Pictou, Colchester and Halifax, Nova Scotia, from 1882 to 1886. Can. Geol. Surv., *Ann. Rept.*, **2**, 16P, 125P, 163P (1887).

Flynn, A. E.—Report on China Clay (Kaolin) Deposit at Middleton, Annapolis County, Nova Scotia. Dept. of Public Works and Mines, p. 269 (1924).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **6,** 87–8R (1895); **9,** 52R (1898); **11,** 55R (1900); **12,** 60R (1901); **13,** 59R (1903).

Keele, J.—Clays and Shales in the Maritime Provinces. Can. Geol. Surv., *Sum. Rept., 1909,* pp. 245–6 (1910).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916,* p. 111.

Keele, J.—Investigations of Clay and Shale Resources of Canada. Can. Mines Branch. *Sum. Rept., 1917,* pp. 97–120.

Mason, F. H.—Potters Clay at Middle Musquodoboit (Nova Scotia). Can. Min. Rev., **20,** 175–6 (1901). (Abs., *Geol. Centralb.*, **3,** 329 (1903).)

Poole, H. S.—Report on the Pictou Coal Field, Nova Scotia. Can. Geol. Surv., *Ann. Rept.*, **14,** 12, 36–8 (1904).

Ries, H.—The Clay and Shale Deposits of Nova Scotia. *Jour. Min. Soc.*, **15,** 9–26 (1910). (Abs., *Geol. Centralb.*, **16,** 84 (1911).)

Ries, H. and Keele, J.—The Clay and Shale Deposits of Nova Scotia and Portions of New Brunswick. Geol. Surv. of Can., *Memoir,* **16,** 164 pp. (1911). (Abs., *Geol. Centralb.*, **17,** 636 (1911–12).)

Selwyn, A. R. C.—Summary Reports of the Operations of the Geological Survey for the Years 1887 and 1888. Can. Geol. Surv., *Ann. Rept.*, **1,** 23A (1886); **3,** 99A (1887–88); and for 1890, **5,** 59AA (1893); 1892, **6,** 53A (1895).

Ontario

Anon.—Mattagami China Clay Deposits. Can. Chem. and Met., **8** [11], 266 (1924).

Baker, M. B.—Clays and Clay Industries of Ontario. *The Clayworker,* **45,** 850 (1906).

Baker, M. B.—Clays of Ontario. *Can. Min. Jour.*, **30,** 244–5 (1909).

Baker, M. B.—Our Visible Supply of Brick. *Can. Min. Jour.*, **30,** 100–2 (1909).

Baker, M. B.—Clay and the Clay Industry of Ontario. Ontario Bur. of Mines, *Rept.*, **15** (1906).

Baker, M. B.—Clay Deposits and Works near Toronto. 12th Int. Geol. Cong., Canada, *Guide Book,* No. **6,** 49–53 (1913).

Barlow, A. E.—Report on the Geology and Natural Resources of the Area Included by the Nipissing and Temiscaming Map-Sheets. Can. Geol. Surv., *Ann. Rept.*, **10,** 157 I (1899).

Bell, R.—Summary Report on the Operations of the Geological Survey for the Calendar Year 1902. Can. Geol. Surv., *Ann. Rept.*, **15,** 221A (1903); and for 1904, **16,** XXXA (1905).

Ells, R. W.—Report on the Geology and Natural Resources of the Area Included in the Map of the City of Ottawa and Vicinity. Can. Geol. Surv., *Ann. Rept.*, **12,** 48G (1901).

Ells, R. W.—Report on the Geology of a Portion of Eastern Ontario (To Accompany Map-Sheet No. 119). Can. Geol. Surv., *Ann. Rept.*, **14,** 74J (1904).

Hoffmann, G. C.—Chemical Contributions to the Geology of Canada, from the Laboratory of the Survey. Can. Geol. Surv., *Ann. Rept.*, **4,** 67R (1890); **7,** 67R (1896); **13,** 60–1R (1903).

Keele, J.—Notes on Tests of Clay Samples. Can. Geol. Surv., *Sum. Rept., 1911,* pp. 233–4 (1912).

Keele, J.—Investigation of the Clay Resources of Ontario. Can. Geol. Surv., *Sum. Rept., 1914,* p. 87 (1915).

Keele, J.—Refractory Materials in Canada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Investigation of Clay and Shale Resources of Canada. Can. Mines Branch, *Sum. Rept., 1917*, pp. 97–120.

Keele, J.—Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1918*, p. 162.

Keele, J.—Mesozoic Clays in Northern Ontario. Can. Geol. Surv., *Sum. Rept., 1919, Pt. 6*, pp. 13–9 (1920).

Keele, J.—Clay and Shale Deposits of the Abitibi and Mattagami Rivers. Ont. Bur. Mines, **29** [Pt. 2], 31–55 (1920).

Keele, J.—Mesozoic Clays and Sands in N. Ontario. *Trans. Royal Soc. Can.*, Section 4, 1921.

Keele, J.—Notes on the Clays of the Missinabi River. Ont. Dept. Mines, *Ann. Rept.*, **30** [Pt. I], 171–5 (1922).

Keele, J.—Clay and Shale Deposits of Ontario. Can. Geol. Surv., *Mem.*, **142** (1924).

Lawson, A. C.—Report on the Geology of the Lake of the Woods Region. Can. Geol. Surv., *Ann. Rept.*, **1**, 149CC, 151CC (1885).

Logan, W. E.—Clays and Analyses. Can. Geol. Surv., *Prog. Rept., 1863*, pp. 641, 801, 802, 897, 915 (1863).

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Romanet du Caillaud, F.—Les Roches Kaolinifères du Bassin du Lac Nèpigon (Canada). *Comptes Rend.*, **140**, 361 (1908).

Quebec

Anon.—Canadian China Clay. *British Clayworker*, **24**, 58 (1915–16).

Anon.—The Clays of Quebec. *British Clayworker*, **24**, 113 (1915–16).

Anon.—A China Clay Mine. *Can. Min. Jour.*, **43**, 523 (1922).

Anon.—China Clay in Quebec. *Can. Chem. and Met.*, **7**, 243 (1922).

Dawson, G. M.—Summary Report of the Operations of the Geological Survey for the Year 1895. Can. Geol. Surv., *Ann. Rept.*, **8**, 123A (1896).

Denis, T. C.—Notes, Analyses of the Kaolin from St. Rémi, Amherst Township. Minister Colonization and Mines, *Ann. Rept., 1915*.

Donald, J. T.—Notes on a Deposit of Clay at Côte St. Luc, Montreal, Que. *Can. Rec. Natural History*, **1**, 56–7 (1884).

Dufresne, A. O.—Brickmaking Industry in the Province of Quebec, a Review. Minister Colonization and Mines, *Ann. Rept., 1921*, p. 89–92.

Dufresne, A. O.—Notes on Brick Making at L'Islet Station. Minister Colonization and Mines, *Ann. Rept., 1921*, 65. p.

Dufresne, A. O.—Notes on Occurrences of Vitrifying Shales in the Seigniory of Lapage-Thibierge. Minister Colonization and Mines, *Ann. Rept., 1921*, p. 67.

Ells, R. W.—Report on the Geology of a Portion of the Eastern Townships Relating More Especially to the Counties of Compton, Stanstead, Beauce, Richmond and Wolfe. Can. Geol. Surv., *Ann. Rept.*, **2**, 70J (1887).

Ells, R. W.—Report on the Mineral Resources of the Province of Quebec. Can. Geol. Surv., *Ann. Rept.*, **4**, 133K (1890).

Ells, R. W.—Report on a Portion of the Province of Quebec Comprised in the South-west Sheet of the "Eastern Townships" Map (Montreal) Sheet. Can. Geol. Surv., *Ann. Rept.*, **7**, 90J (1896).

Ells, R. W.—Report on the Geology of Argenteuil, Ottawa and Part of Pontiac Counties, Province of Quebec, and Portions of Carleton, Russell and Prescott Counties, Province of

Ontario. Can. Geol. Surv., *Ann. Rept.*, **12**, 135J (1901).

Hoffmann, G. C.—Kaolinite from Acton. Geol. Surv. Canada, *Prog. Rept., 1874–75*, p. 314 (1876).

Hoffmann, G. C.—Kaolin. Geol. Surv. Can., *Rept. of Progress, 1878–79*, pp. 6–7 H (1880). (Abs., *Jour. Chem. Soc.*, **15**, 545 (1881).)

Hoffmann, G. C.—Annotated List of the Minerals Occurring in Canada. Can. Geol. Surv., *Ann. Rept.*, **4**, 41–2T (1890).

Hoffmann, G. C.—Report of the Section of Chemistry and Mineralogy. Can. Geol. Surv., *Ann. Rept.*, **8**, 14R (1897); **11**, 55R (1900); **13**, 59–60R (1903).

Keele, J.—Clay from Village of Amos, Abitibi County. Minister Colonization and Mines, *Ann. Rept., 1912*.

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Clay and Shale Deposits of New Brunswick. Can. Geol. Surv., *Memoir*, **14** (1914).

Keele, J.—Investigation of Clay Resources of Quebec. Can. Geol. Surv., *Sum. Rept., 1912*, pp. 351–6 (1914).

Keele, J.—Extract from Preliminary Report on Clay and Shale Deposits of Province of Quebec. Minister Colonization and Mines, *Ann. Rept., 1915*.

Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Province of Quebec. Can. Dept. Mines, *Memoir*, **64**, 196 pp. (1915).

Keele, J.—Field Investigations of Clay and Shale Resources. Can. Mines Branch, *Sum. Rept., 1916*, p. 105.

Keele, J.—Kaolin in Quebec (with Discussion by H. Ries and R. R. Hice). *Jour. Amer. Ceram. Soc.*, **1**, 8–14 (1918).

Logan, W. E.—Clays and Analyses. Can. Geol. Surv., *Rept. Progress, 1863*, pp. 641, 801, 802, 897, 915 (1863).

Low, A. P.—Report on the Geology and Economic Minerals of the Southern Portion of Portneuf, Quebec, and Montmorency Counties, Province of Quebec. Can. Geol. Surv., *Ann. Rept.*, **5**, 68–9L (1892).

Ries, H.—Whiteware Materials in Ontario and Quebec, Kaolin near Huberdeau, Que. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 229–32 (1912).

Selwyn, A. R. C.—Summary Report of the Operations of the Geological Survey for the Years 1884 and 1885. Can. Geol. Surv., *Ann. Rept.*, **1**, 55A (1886).

Wilson, M. E.—Description of Kaolin Deposits. Extracts from *Memoir, 113*, Can. Geol. Surv. Minister Colonization and Mines, *Ann. Rept., 1922*, p. 81.

Wilson, M. E.—Geology and Mineral Deposits of a Part of Amherst Township, Quebec. Canada Dept. of Mines, Geol. Surv., *Memoir*, **113**, 54 pp. (1919).

Saskatchewan

Anon.—Fire Clay of Saskatchewan. *Min. and Sci. Press.*, **106**, 534 (1913).

Anon.—Ceramic Deposits in Saskatchewan. *Chem. News*, **126**, 277 (1923).

Anon.—Clay Resources of Southern Saskatchewan, Canada. *Bull. of Imp. Inst.*, **21**, 505 (1923).

Chicanot, E. L.—Clay Industry in Saskatchewan. *Eng. and Min. Jour.-Press*, **116**, 107 (1923).

Davis, N. B.—Clay Resources of Southern Saskatchewan. Can. Dept. of Mines, Mines Branch, *Rept.* **468**, pp. 1–93 (1918). (Abs. in *Jour. Iron and Steel Inst.*, **98** [2], 439 (1918); abs. in *Geol. Mag.*, **6** (1919).)

Keele, J.—Report on Progress of Investigation of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 234–9 (1912).

Keele, J.—Refractory Materials in Can-

ada. Can. Mines Branch, *Sum. Rept., 1916*, p. 111.

Keele, J.—Clay and Shale Deposits of the Western Provinces. Part V. Can. Geol. Surv., *Memoir*, **66**, 74 pp. (1915).

Pacana, L.—Clay Deposits in Saskatchewan. *British Clayworker*, **32**, 88 (1923–24).

Ries, H.—Clay and Shale Deposits of Western Canada. Can. Geol. Surv., *Sum. Rept., 1910*, pp. 174–80 (1911).

Ries, H.—The Clay and Shale Deposits of the Western Provinces of Canada. Can. Min. Inst., *Quart. Bull.*, **16**, 11–54 (1911). (Abs., *Geol. Centralb.*, **17**, 637 (1911–12).)

Ries, H.—Report on Progress of Investigations of Clay Resources. Can. Geol. Surv., *Sum. Rept., 1911*, pp. 225–9 (1912).

Ries, H. and Keele, J.—Preliminary Report on the Clay and Shale Deposits of the Western Provinces. Can. Geol. Surv., *Memoir*, **24**, 21 pp. (1912).

Ries, H. and Keele, J.—Report on the Clay and Shale Deposits of the Western Provinces. Canada; Part II. Can. Geol. Surv., *Memoir*, **25**, 105 pp. (1913).

Rose, B.—Wood Mountain-Willowbunch Coal District. Can. Geol. Surv., *Mem.*, **89**.

Spence, H. S.—Bentonite. Can. Mines Branch, *Rept.*, **626** (1924).

Stansfield, J.—Banded Precipitates of Vivianite in a Saskatchewan Fire Clay. *Geol. Mag.*, **59** [698], 356 (1922).

Wilson, A. W. G.—Saskatchewan Clays and New Industries. *Nat. Resources of Can.*, **2**, July (1923).

MEXICO

Anon.—Análisis de arcillas del subsuelo del Palacio del Poder Legislativo Federal y del subsuelo del edificio de la Secretaría de Comunicaciones. *Parergones del Inst. Geol. de Mex.*, **5** [4], 182–7 (1913).

Anon.—Catálogo Sistemático de las Especies Minerales de México y sus aplicaciones Industriales. *Bol. del Inst. Geol. de Mex.*, No. 40 (1923).

Anon.—Catálogo Geográfico de las Especies Minerales de México. *Bol. del Inst. Geol. de Mex.*, No. 41 (1923).

Anon.—Kaolin in Mexico. *Chem. Age*, **9**, 14 (1923).

Aguilera, J. G.—Catálogo Sistemático y Geográfico de las especies minerálogicas de la República Mexicana. *Bol. del Inst. Geol. de Mex.*, No. 11 (1898).

Aguilera, J. G.—Los kaolines de la hacienda de exthō (State of Hidalgo, Mex.). Soc. Geol. Mex., *Bull.* **3**, 25–33 (1906).

Castro, C.—Análisis de una kaolinita encontrada en una muestra de carbón de Villafuente, Coahuila. *Bol. de la Sociedad Geol. Mex.*, **5**, 10, 147–50 (1908).

Del Río, A.—Las Arcillas de México. *Bol. Ofic. de la Sec. de Agricult. y Fom.*, **4**, Ser. 5a [3–4], 181–6 (1919).

Del Río, A.—Las Arcillas de México. *La Farmacia*, **IIa**, Epoca, No. 5, pp. 73–7 (1925).

Hilgard, E. W.—A Peculiar Clay from near Mexico City. *Proc. Nat. Acad. Sci.*, **2**, 8–12 (1916); *Bol. Minero*, **3** [1], 16–9 (1917).

Orvañanos, B.—Breves consideraciones para el estudio de las Arcillas que tienen aplicación entre las materiales de construcción. *Ann. del Inst. Geol. de Mex.*, No. 6 (1919).

Zárate, J. C.—Estudio y análisis de unas arcillas procedentes de la hacienda de Gloria, municipalidad de Altamira, Estado de Tamaulipas. *Bol. Minero*, **2** [3], 111–9 (1916).

Zárate, J. C.—Viaje de la isla de San Marcos a Mulegé, Boja California e Informe acerca de los Depósitos de kaolín. *Bol. de Industria Comercio y Trabajo*, **3** [3], 114–6 (1919).

SOUTH AND CENTRAL AMERICA

SOUTH AMERICA

General

Miller, B. L. and Singewald, J. T., Jr.—The Mineral Deposits of South America (1919).

Wilson, O.—Minerals, Earths and Clays of Latin America. *Chem. Met. Eng.*, **26,** 631–6, 697–700, 745–9 (1922).

Argentine

Zamboni, M. A.—The Clays of the Tandil Mts., Argentine Republic. *Anales. Soc. Quim. Argentina,* **8,** 190–9 (1920).

Brazil

Calogeras, J. P.—As minas do Brazil e sua legislação (1905), *Clays and Kaolin,* **2,** 552–6.

Derby, O. A.—On the Association of Argillaceous Rocks with Quartz Veins in the Region of Diamantina, Brazil. Description of Clay and Kaolin with Analysis by Hussak. *Amer. Jour. Sci.,* **158,** 343–56 (1899). (Analysis reprod. in Groth's *Zeits. f. Kryst. u. Min.,* **34,** 101 (1901).)

British Guiana

Anon.—Kaolin in British Guiana. *Tonind. Zeit.,* **25** [126], p. 1903 (1901).

Emory, L. T.—Bauxite Deposits of British Guiana. *Eng. Min. Jour.-Press.,* **119,** 686 (1925).

Emory, L. T.—Prospecting for Bauxite in British Guiana. *Eng. and Min. Jour. Pr.,* **119,** 45 (1924).

Harrison, J. B.—Laterites in British Guiana. *Geol. Mag.,* **7,** 439–52, 488–95, 553–62 (1910).

Chili

Anon.—Mineralojia, 3rd Ed., p. 569 (1879).

French Guiana

Fermor, L. L.—The Work of Professor La Croix on the Laterites of French Guiana. *Geol. Mag.,* **2,** 28–37, 77–82, 123–9 (1915).

Jannettaz, E.—Gibbsite et Bauxite de la Guyane Française. *Bull. de la Soc. Min. de France,* **1,** 70–1 (1879).

Meunier, S.—Sur l'existence de la Bauxite à la Guyane Française. *Comptes Rendus Acad. Sci.,* **74,** 633–4 (1872). (Abs., *Jahresbericht der Chemie,* 1099 (1872).)

WEST INDIES

Cuba

Brown, H. C.—Mineral Resources of Cuba, 1901. *Civil Report of Brig. Gen. Wood* (Military Govr. Cuba, 1902), **5** [2], 106–17 (1902).

Dominican Republic

Condit, D. D. and Ross, C. P.—A Geological Reconnaissance of the Dominican Republic. Official Publication of the Secretaryship of State of Fomento and Communications, Dominican Republic. Prepared by the U. S. Geol. Surv., *Memoirs,* **1,** 249 (1921).

Porto Rico

Gile, P. L. and Ageton, C. N.—The Red Clay Soil of Porto Rico. *Porto Rico Agr. Expt. Sta.*, **14,** 1–24 (1914).

St. Vincent

Anon.—The Kaolin of St. Vincent. *British Clayworker*, **12,** 81 (1903–04).

Anon.—Kaolin from St. Vincent. Imp. Inst., *Bull.* **1,** 19–20 (1903).

EUROPE

Austria

Anon.—Die Kaolingruben im Vincentischen. *Oesterr. Zeits. f. Berg.-u. Hüttw.*, **69,** 217 (1901).

Anon.—Austrian Kaolin. *British Clayworker*, **30,** 247 (1921–22).

Helmhacker, R.—Bauxite in Austria. *Eng. Min. Jour.*, **66,** 457 (1898).

Knaffl, L.—Untersuchung der in Oesterreich Vorkommenden und zur Erzeugung Feuerfester Materialien Benutzten Thone und Kaolinerden. *Dingler's Polytech. Jour.*, **174,** 292.

Kovář, F.—Chemische Untersuchung von fünf Mineralien aus Mähren. (Analysis of Kaolin.) (Extr. from *Abhandl. d. böhm Akad.*, **15** [1], p. 18, böhm.) Groth's *Zeits. f. Krystallog. u. Min.*, **31,** 524 (1899).

Kovář, J.—Chemische Untersuchung einiger Mineralien von Vicz bei Bistritz am Bernstein in Mähren (Analysis of Kaolin.) (Extr. from *Chemische Blätter*, 1899. Böhmisch.) Groth's *Zeits. f. Krystallog. u. Min.*, **34,** 706–7 (1901).

Lipold.—Kaolin von St. Martin im Bacher Gebirge in Steiermark. *Jahrb. Geol. Reichsanstalt*, **9,** 46.

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 435–45 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 372 (1901).

Schneider, L.—Zusammensetzung von Bauxit von Krain. *Dingler's Polytech. Jour.*, **224,** 334.

Van der Leeden, R.—Über ein durch atmosphärische Verwitterung enstandenes Kaolin vorkommen bei Schwanberg in Steiermark. *Centralblatt für Mineralogie, Geologie und Paläontologie*, pp. 489–92 (1910).

Weithofer, A.—Occurrence of Fire Clay in the Kladno Coalfield. Verhandlungen des Naturf. *Vereins. Brünn.*, **43,** 44. (Abs. in *Jour. Iron and Steel Inst.*, **69** [1], 319 (1906).)

Belgium

Anon.—Technical Excursion in the North and in Belgium. *Ceramique*, **25,** 193–7, 241–51 (1922).

Asselberghs, E.—Kaolin of Belgium. *Ann. Mines. Belg.*, **21,** 1059–67 (1920). (Abs., *Rev. Geol.*, **1,** 292–3 (1920).)

Jérdine, A.—Discovery of a Notable Deposit of Kaolin in Ardenne. *Bull. Soc. Belg. Geol.*, **21,** 217–22 (1908).

de Koninck.—Über den Kaolinite von Quenast und aus der Steinkohlenformation. Recherches sur les minéraux Belges IV., *Bull. Acad. Belg.*, **44** [12], 2 (1877).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI*, p. 55 (1898).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 372, 373 (1901).

Simoens, G.—Observations faites au gisement Kaolinifère de Lebin. *Bull. Soc. Belg. Géol., Brux.*, **21,** 1907 (1908), Proc. verb., pp. 222–4.

Bosnia

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 373 (1901).

Bulgaria

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 373 (1901).

Czechoslovakia

Anon.—The Bunz Clays. *Tonind. Zeit.*, **33,** 763–5 (1919).

Bauer, A.—Analyse eines Kaolins von Zettlitz bei Karlsbad. *Sitzungsber, k. Akad. Wiss.*, **22,** 693. (Abs., *Neues Jahrb. für Mineral.*, p. 569 (1858).)

Burian, J.—Technical Study of Bohemian Clays. *Chem. Listy*, **6,** 62–4.

E. H.—Ceramic and Paper Kaolin. *Tonind. Zeit.*, **44,** 439 (1920).

Gabert, C.—Neue Aufschlüsse in Böhmischen Kaolinlagerstätten. *Zeits. f. Prakt. Geol.*, **17,** 142 (1909).

Haskovec, A.—Keramické suroviny okolí Bechyně. *Časopis pro průmysl chemický*, 116–8 (1900). (Abs., *Geol. Centralb.*, **1,** 616 (1901).)

Hochstetter, F. v.—Karlsbad, seine geognostischen Verhältnisse und seine Quellen (1856); also *Sitzungsber. k. Akad. Wiss.*, **20,** 13 (1856).

Hoff, v. K. E. A.—Geognostische Bemerkungen über Karlsbad. *Gotha* (1825).

Jokély, I.—Zur Kenntniss der geologischen Beschaffenheit des Egerer Kreises. *Jahrb. geol. Reichsanst.*, **7,** 479 (1856) and **8,** 1 (1857).

Kanka, A.—Refractory Clays in Mahr Truban, Czechoslovakia. *Montan. Rundschau.* **16,** 81–7 (1924).

Katzer.—Geologie von Böhmen.

Kovář, F.—Analysen einiger Mineralien aus den Graphitbergwerken bei Malý Tresný in Mähren. (Kaolin.) *Časopis pro prům. Ysl. chemický*, 1898.

Kovář, F. and Haskovec, A.—Über zwei feuerfeste Thone von Vranavá bei Křetin in Mähren. *Zeits. für chem. Industrie*, 3 p. (1899).

Laube, G. C.—Geologie des böhmischen Erzgebirges, 1st Theil. *Archiv. d. naturw. Com.*, 1876.

Laube, G. C.—Geologische Excursionen im böhmischen Thermalgebiet. (1884)

Löwl, F.—Die Verbindung des Kaiserwalds mit dem Erzgebirge. *Jahrb. geol. Reichsanst.*, **31,** 454 (1881).

Purkyně, C. v.—Kaolin v. kamenouhelné páuvi Plzenské. *Časopis pro průmysl chemický* (1901). (Abs. in *Geol. Centralb.*, **2,** 780 (1902).)

Purkyně, C.—Ložiska kaolinová v. Plzeňsku (Kaolin deposits at Pilsen). *Mit 1 Abbild. Vesmir, Prag*, **31,** No. 7 (1902). (Abs., *Geog. Centralb.*, **3,** 145 (1903).)

Safarik.—Über böhmische Kaoline. *Sitzungsber. d. K. böhm. Ges. d. Wissensch.*, **16,** Feb. (1870).

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 232 (1911).

Denmark

Anon.—British China Clay in Denmark. *The British Clayworker*, **28,** 220 (1919–20).

Braun.—Über die Morphologie von Bornholm. *Jahresber. d. Geogr. Ges.*, **9,** 163–200 (1908).

Cohen, E. and Deecke, W.—Über das krystalline Grundgebirge der Insel Bornholm. *Jahresber. geol. Ges.*, **6,** (1889).

Elssing, N. V.—Kaolin on Island of Bornholm. *Danm. Geol. Unders. II, R. 1 Yr.*, **12,** 60 (1902).

Forchhammer, G.—Oversigt over Dan-

marks geogn. Bygning. *Förhandl. vid Skand. Naturforsk. Möte Stockholm*, p. 29.

Forchammer, G.—Om dë Bornholmske Kulformationer. *Vidensk. Selsk. naturvid. och mathem. Afhandl.*, **7**, 18 (1837).

Jacobsen, C.—Ceramic Industry. *Trans. Eng. Ceram. Soc.*, **22**, 20 (1922–23). (Abs., *Jour. Amer. Ceram. Soc.*, **7**, 28 (1924).)

Johnstrup, F.—Abriss der Geologie von Bornholm, als Führer zu der Excursion der deutschen geologischen Gesellschaft, p. 10 (1889).

Richards, J. W.—Danish Clay. *Electrochem. and Metal. Ind.*, **7**, 474–5. (Abs. in *Jour. Iron and Steel*, **81** [1], 558 (1910).)

Ries, H.—Clayworking in Denmark. *The Clayworker*, **29**, 498 (1898).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 445–8 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 374 (1901).

Rordam, K.—Undersøgelse af Mesozoiske Lerarter og Kaolin paa Bornholm i geologisk og teknisk. Henseende. *Dan. geol. Undersøg.*, Scr. II, pp. 1–109 (1890).

Seger, H.—Die Thonindustrie auf der Insel Bornholm. *Gesammelte Schriften*, p. 477.

Winkel, H. E.—Kaolinslemmeriet "Rabekkegaard" poa Bornholm. *Kjöbenhavn Tekn. Forenings Tidsskrift* (1885).

Elba

Brogniart, A.—Über Porcellanerde, etc. *Bull. soc. geol. France*, **10**, 56 (1839); *Compt. rend.*, **7**, 1085; *Jour. prakt. Chem.*, **17**, 118 (1839); *Archiv d'mus. d'hist. nat.*, **8**, 446 (1840).

Finland

Aarnio, B.—Lerornas konsistense genskaper. Hygroskopiciteten has gelerna Fe_2O_3, Al_2O_3 och SiO_2, vid olika temperaturer. *Geologiska kom., Geotekniska meddelanden*, Nos. 24 and 25.

Anon.—China Clay in Finland. *The British Clayworker*, **30**, 215 (1921–22).

Frosterus, B.—Bildrag till kännedomen om våra lerors tekniska egenskaper. *Geologiska kom., Geotekniska meddelanden*, No. 1.

Frosterus, B.—Det finska lermaterialet som geologisk bildning och teknisk produkt. *Geologiska kom., Geotekniska meddelanden*, No. 6 (1909). (Abs., *Geol. Centralbl.*, **15**, 71 (1910–11).)

Frosterus, B.—Lertekniska studier: Vattenhalten i våra tegelleror. Försök att genom tillblandningar höja smältpunkten hos finsk lera. *Geologiska kom., Geotekniska meddelanden*, No. 9.

Frosterus, B. and Glinka, K.—Zur Frage nach der Einteilung der Böden in Nordwest-Europas Moränengebieten. *Geologiska kom., Geotekniska meddelanden*, No. 11., Pts. I and II.

Frosterus, B.—Zur Frage nach der Einteilung der Böden in Nordwest-Europas Moränengebieten. *Geologiska kom., Geotekniska meddelanden*, No. 13, Pt. IV and No. 14, Pt. V.

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 375 (1901).

Sederholm, J. J.—Om de Tekniska egenskaperna has finska granites. *Geologiska kom., Geotekniska meddelanden*, No. 8.

Väyrynen, H.—The Geological Relations of an Occurrence of Kaolin in the Finnish Grundgebirge. *Geol. För. Förh*, **46**, 393–406 (1924).

France

Anon.—Bauxite in France. *Eng. and Min. Jour.*, **74,** 242 (1902).

Anon.—A French Kaolin Deposit. *Moniteur de la Céramique.* (Abs. in *British Clayworker*, **11,** 93 (1902–03).)

Anon.—Visit to the Kaolin Quarries of the Region d'Echassières, Allier. *Rev. Mat. Constr. Trav. Pub.*, **181,** 220–7B (1924).

Alluand.—Rapport sur les Grès Molasses ou Granits Arénacés Kaoliniques de Degnac (1832).

Augé.—Note sur la Bauxite, son Origine son Âge et son Importance Géologique. *Bull. Soc. Geól., France*, 3rd Ser., **16,** 345 (1888).

Auscher.—Les Céramiques Cuisant á Haute Température (Kaolins.) p. 21.

Auscher and Quillard.—Technologie de Céramique. (Kaolins.) p. 23 (1901).

Baret.—Sur une Argile de la Carrière du Rocher-d'Enfer sur les Bords de l'Erdre près Nantes. *Bull. Soc. Minéral, France*, **7,** 118–20 (1885). (Abs. in *Jahrbuch für Mineral.*, **2,** 35 (1887).)

Baud, E.—Industrie et Analyse de la Bauxite. *Rev. Gén. de Chimie*, **6,** 368–71 (1903).

Becquerel.—De l'Argile plastique d'Autenil, et des Substances qui l'Accompagnent. *Ann. de Chim. et de Physique*, p. 348 (1823). (Abs. in *Bull. Gén. et Univ. des Annonces*, **7,** pp. 40–1 (1823).)

Berthier, P.—Analyse de l'Alumine Hydratée des Beaux, Département des Bouches-du-Rhône. *Annales des Mines*, Ser. 2, **6,** 531 (1821).

Berthier, P.—Über Kaolin und einige Thonarten. *Annal. chim. phys.*, **60** (1836); *Jour. für prakt. Chemie*, **10,** 28 (1837).

Berthier, P.—Sur le Kaolin et sur les Argiles. *Annales de Chimie et de Physique*, **62,** 225–42 (1836); also *Jour. für prakt. Chemie*, **10,** 28–41 (1837).

Bougerel, G. L.—Constitution et Formation des Bauxites. *Moniteur Scientifique*, **51,** 21–2 (1898).

Brongniart, A.—Premier mémoire sur les kaolins, ou argiles à porcelaine, sur la matière, le gisement, l'origine et l'emploi des cette sort d'argile. Extr. *Archives du Musée d'Hist. Nat.*, **1,** 243–302 (1839).

Brongniart, A.—Über Porcellanerde, etc. *Bull. soc. géol. France*, **10,** p. 56 (1839); *Compt. Rend.*, **7,** 1085; *Jour. prakt. Chemie.*, **17,** 118 (1839); *Archiv. d. Musée d'Hist. Nat.*, **8,** 446 (1840).

Brongniart, A., and Malaguti.—Second mémoire sur les kaoline, ou argile à porcelaine. *Compt. Rend.*, **13,** 735–54 (1841). *Archives Muséum d'Hist. Nat.*, **2,** 217–305 (1841); *Jour. für Prakt. Chemie*, **31,** 129–60 (1844); *Annales des mines*, 4th Ser., **2,** 465–74 (1842).

Burat, A.—Minéralogie appliquée. Description des Minéraux Employés dans les Industries, etc. (Argiles, Kaolins, Analysis.) Pp. 260–9 (1864).

Caumont, M. de.—Note sur le Kaolin du Department de la Manche. *Mém. de la Soc. Linnéenne de Normandie* (1826–27). (Abs. in *Bull. Sci. Nat. et de Géol.*, **10,** pp. 253–54 (1828).)

Charpentier, H.—Geologie et Minéralogie Appliquées. Les Minéraux et leur Gisements. L'Alumine et ses Composés; Alum, Argiles, Kaolin, pp. 532–8 (1900).

Collot, L.—Âge des Bauxites du sud-est de la France. *Bull. Soc. Géol. France*, 3rd Ser., **15,** 331–45. (Abs. in *Trans. North of Eng. Inst. Min. Eng.*, **37,** 4 (1888).)

Collot, L.—Sur la Bauxite d'Allières. Description Géologique des Environs d'Aix en Provence. (Bauxite.) p. 84 (1880).

Collot, L.—Âge de la Bauxite dans le sud-est de la France. *Compt. Rend.*, **104,** 127–30 (1887).

Coquand.—Sur les Bauxites de la Chaîne

des Alpines (Bouches-dur-Rhône) et leur Âge Géologique. *Bull. Soc. Géol. France*, 2nd Ser., **28,** 98–115 (1870–71).

Coudroy, G. du.—Notice sur les Argiles Kaolinique de Gaudry (Nièvre). *Bull. Soc. Hist. Nat.*, **12,** p. 2, 277. (Abs., *Geol. Centralb.*, p. 675 (1901).)

Curioni.—Analyses of Two Kaolins from Lombardy. *Ann. des Mines*, Ser. 7, **13,** 364 (1878).

Damour.—Notice et Analyses sur un Kaolin Produit par la Décomposition du Béryl. *Bull. Soc. Géol. France*, 2nd Ser., **7,** 224–31 (1849–50).

Damour, A.—Argile Rose des Environs de Nantes. *Bull. Soc. Min. de France*, **13,** pp. 305–6 (1885).

D'Aoust, V.—Sur le Mineral Fer Alumineux Pisolithique de Mouriès, et aussi des Baux. *Bull. Soc. Géol. France*, 2nd Ser., **22,** 418–20 (1864–65).

Daubrée, A.—Sur l'Existence de Gisements de Bauxite dans les Départments de l'Hérault et de l'Ariége. *Bull. Soc. Géol. France*, 2nd Ser., **26,** 915–8 (1868–69).

Daubrée, A.—Note sur le Kaolin de la Lizelle, etc. *Comptes Rendus Acad. Sci. Paris*, **68** 1135–9 (1869).

Daubrée, A.—Note sur un Silicate Alumineux Hydraté, Déposé par la source Thermale de Saint-Honoré (Nièvre) depuis l'Epoque Romaine. *Comptes Rendus Acad. Sci. Paris*, **83,** 421 (1876).

Daubrée, A.—Les Eaux Souterraines aux Epoques Anciennes (1887). (Kaolin, pp. 178–80, 313; Bauxite, pp. 95–97.)

Delesse, A.—La Formation du Granite en Arène et en Kaolin. *Bull. Soc. Géol. France*, 2nd Ser., **10,** 256–64 (1852–53).

Delesse, A.—Remarques sur le Granite et sur les Roches Métamorphiques. *Bull. Soc. Géol. France*, 3rd Ser., **3,** 154–60 (1875).

Diday.—Analyse de Kaolin de Grimaud (Départ. Var.). *Ann. des Mines*, Ser. 3, **18,** 725–6 (1840).

Dieulafait.—Les Bauxites, Leurs Âges, Leur Origine. *Comptes Rendus Acad. Sci. Paris*, **93,** 804–7 (1881).

Dieulafait.—Origin of Phosphorites and Ferruginous Clays in Limestone Districts. *Jour. Chem. Soc.* (*Abstracts*), **46,** 1272 (1884).

Durand-Claye.—Kaolin de Gavaudun, Lot-et-Garonne. *Ann. des Mines*, Ser. 7, **13,** 364 (1878).

Fournet, J.—Mémoire sur la decomposition des Minéraux d'Origine Ignée et leur Conversion en Kaolin. *Annales de Chimie et de Phys.*, **55,** 226–56 (1834). (Abs. *Neues Jahrbuch für Mineral*, pp. 85–8 (1836).)

Fuchs and de Launay.—Traité des Gîtes Minéraux (1893).

Gasparin, P. de.—Sur la Constitution des Argiles. *Comptes Rendus Acad. Sci.*, **74,** 1180 (1872). (Abs. *Chem. News*, **25,** 275 (1872).)

Gourret, P. and Gabriel, A.—La Bauxite et les Étages qui la Recouvrent dans le Massif de Garlaban. *Comptes Rendus*, **106,** 1551–3 (1889).

Granger, A.—Sur la Composition des Argiles, d'après M. Vogt. *Moniteur Scientifique*, **50,** 798–806 (1897).

Griffin, W. T.—The Treatment of Kaolin at Limoges. Quoted in *Eng. and Min. Jour.*, **64,** 401 (1897).

Gruner, L.—Observations sur les Minerai de Fer en Grains ou Minerai Pisiforme. (Origin of Bauxite.) *Bull. Soc. Géol. France*, **23,** 2nd Ser., pp. 200–5 (1870–71).

Guillemin.—Pholerit from Fins (Allier.) *Annal. de Min.*, **11,** 489 (1825).

Hébert, E.—Observations sur l'Argile Plastique, et les Assise qui l'Accompagnent dans la Partie Méridionale du Bassin de Paris. 24 pp. (1854).

Hinstin.—Notice sur les Kaolins de l'Allier et les Blanc de Meudon. *Bibliothèque de l'École des Mines de Paris* (1889).

Jannettaz, E.—La Composition d'un Variété Pisolithique de Bauxite.

Bull. Soc. Géol. France, **6**, 392 (1877–78).

Jerome, A. and Simoens, G.—De la Découverte d'un Gisement de Kaolin en Ardenne. *Bull. Soc. Belge Geol., Brux*, **21** (1907), *Procès verb.*, pp. 217–22.

Körner, J. A.—Beitrag zur Kenntnis der Elsässer Thone. *Inaug.-Diss.*, Erlangen (1900).

Lacvivier, M. de.—Etudés Géologiques sur l'Ariège. (Bauxite, p. 90.)

Lacroix, A.—Minéralogie de la France, **1** (1893).

Lapparent, A. de.—Kaolins du Lot-et-Garonne de Lombardie, de Thuringe; Kaolinisation. Revue de Géologie, *Ann. des Mines*, 7th Ser., **13**, 364 (1877).

Lapparent, A. de.—Traité de Geologie. Kaolin, Argiles Refractaires, Bauxite, pp. 1388–9, 2nd ed. (1885).

Launay, L. de.—Note sur les Gisements de Kaolin de la Forêt des Colettes (Allier). *Bull. Soc. Géol. de France*, Ser. 3, **16**, pp. 1065–72 (1887–88).

Launay, L. de.—Les Kaolins de l'Allier *La Nature*, **1446**, 161–3; (Abs. *Geol. Centralb.*, **1**, 583 (1901).)

Launay, L. de.—Excursion à quelques Gîtes Minéraux et Métallifères du Plateau Central. Extr. du *Compt. Rend.*, **8**, Congrès Géologique International, 1900, Paris, 1901. (Carrières de Kaolin des Colettes (Allier), pp. 18–20.)

Launay, L. de.—Observations sur les Kaolins de St. Yrieux. *Ann. des Mines*, **3**, 5–49 (1903).

Launay, L. de.—Traité de Métallogénie, Gîtes Minéraux et Métallifères, **1**, 802–15 (1913).

Laur, F.—Les Bauxites. *Bull. Soc. Ind. Min.*, 3d Ser., **8**, 513–26 (1894).

Lavezard, E.—Contribution à l'Étude des Argiles de France. *Trans. Inst. Min. Eng.*, **36** (1908–09).

Lavezard, E.—Contribution à l'Étude des Argiles de France. Mem. Publiés par la Société d'Encouragement pour l'Industrie Nationale, p. 113 (1906).

Lavezard, M. E.—Étude sur l'Argile. *Bull. Soc. d'Encour.*, **106**, 65–7 (1904).

Laville, M.—Étude géologique sur les Gisements des Argiles de France. *Mem. Soc. d'Encouragement pour l'Industrie Nationale* (1906).

LeChatelier, H.—Sur la Constitution des Argiles. *Comptes Rendus Acad. Sci., Paris*, **104**, 1517–20 (1887); *Bull. Soc. Chemique*, **48**, 116–24 (1887); Abs. in *Berichte*, **20**, 454 (1887); *Jour. Chem. Soc., London*, **52**, 785 (1887); *Chemical News* **55**, 309 (1887); *Zeits. phys. Chemie*, **1**, 398–402 (1887).

Lefort.—Sur la formation du Kaolin (Rhétien) dans la Nièvre (1884).

Linau, H.—Analysen Französischer Bauxite. *Chemiker Zeits.*, **27**, 422–4 (1903).

Meunier, S.—Sur l'Origine et le Mode de Formation de la Bauxite et du Fer en Grains. *Comptes Rendus Acad. Sci. Paris*, **96**, 1737 (1883).

Meunier, S.—Réponse à des observations de M. Augé et de M. A. de Grossouvre sur l'Histoire de la Bauxite et des Minerais Siderolithiques. *Bull. Soc. Géol. France*, Ser. 3, **17**, 64–7 (1889).

Meunier, S.—Origine de l'Argile à Silex. *Bull. Soc. Géol. de France*, Ser. 4, **1**, 197–8 (1901).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 401–2 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, 375–82 (1901).

Roule, L.—Sur les Gisements et l'Âge de la Bauxite dans le sud-est de la France. *Comptes Rendus*, **104**, 383–5 (1887).

Schmidt, C. and Hinden, F.—Geological and Chemical Investigation of the Clay Deposits at Alsace and at Allschwyl near Basle. *Zeits. prakt. Geol.*, **15**, 46–56 (1907).

Seger, H.—Über einige Rohmaterialien

der Porcellanfabrikation in Limoges. *Ges. Schriften*, p. 550.

Thurmann, J.—Essai de Phytostatique, etc. 1850 (Kaolin).

Vogt, G.—Clays of France. *Bull. Société d'Encouragement* **103,** pp. 937–40. (Abs. in *Jour. Iron and Steel Inst.*, **67** [1], 560 (1905).)

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 234 (1911).

Germany

Ahrens, B.—Der rote Kaolin von Kreisau in Schlesien. *Chem. Zeit.*, **2,** 716 (1903).

Ammon, v. L.—Die Malgersdorfer Weisserde. *Geognost. Jahreshefte*, **13,** 195–208 (1900). (Abs., *Geol. Centralb.*, **2,** 164 (1902).)

Anon.—Thonanalysen. *Dingler's Polytech. Jour.*, **229,** 451–5 (1878).

Anon.—Über feuerfeste Materialien. *Berg.-unt Hüttenmännische Zeitung*, **45** [36], 381 (1886); **45** [37], 392–4 (1886).

Anon.—Neu entdeckte Kaolinlager. *D. Töpfer-u. Ziegler-Ztg.* (1910). (Abs. *Geol. Centralb.*, **17,** 637 (1911–12).)

Anon.—Clay and Kaolin Works in Saxony. *Tonind. Ztg.*, **44,** 1062 (1920).

Anon.—The Clay and Kaolin Works of Saxony. *Tonind. Ztg.*, **46,** 599 (1922).

Backofen and Stremme.—Das Verhalten des Teplitzer Quarzporphyres unter dem Moor bei Zinnwald. *Sprechsaal* (1911).

Barnitzke, J. E.—Über das Vorkommen der Porzellanerde bei Meissen und Halle A. S. *Zeits. f. prakt. Geol.*, **17,** 457–73 (1909).

Bischof, C.—Pyrotechnische Werthbestimmung des Bekannten Selingenberger Thones, Sorte I und II, im Vergleiche zu einander. *Dingler's Polytech. Jour.*, **174,** 49–53 (1864).

Bischof, C.—Pyrotechnische Werthbestimmung des Thones von Schwarzenfeld bei Schwamdorf in Bayern und des in Verbindung damit Benutzten Sandes aus dem Flusse Naab, Nebst Chemischen Analyse des Ersteren. *Dingler's Polytech. Jour.*, **175,** 447–51 (1865), and *Jahresbericht der Chemie für, 1865*, p. 800.

Bischof, C.—Analyse nebst Pyrometrischer Werthbestimmung Zweier im Handel vorzugsweise Bekannten, rheinischen feuerfesten Thone. *Dingler's Polytech. Jour.*, **183,** 29–34 (1867).

Bischof, C.—Analyse nebst Pyrometrischer Werthbestimmung des bekannten und zu Glashäfen vorzüglich gesuchten feuerfesten Thones von Grünstadt. *Dingler's Polytech. Jour.*, **135,** 39–42 (1867).

Bischof, C.—Werthstellung verschiedener Kaoline untersich durch Pyrometrische Bestimmung. *Dingler's Polytech. Jour.*, **198,** 396–413 (1870). (Abs. *Quart, Jour. Chem. Soc.*, **9,** 40 (1871).)

Bischof, C.—Pyrometrische Werthbestimmung eines bei Strehlen in Schlesien Aufgefundenen Kaolins, nebst Chemischer Analyse des durch Schlämmen daraus gewonnenen Materials. *Dingler's Polytech. Jour.*, **199,** 307–10 (1871).

Bischof, C.—Pyrometrische Untersuchung des bekannten ausgezeichneten Thonworkommens bei Eisenberg. *Deutsch Ind. Zeitung*, p. 333 (1871). (Abs., *Chem. Centralb.*, p. 719 (1871).)

Bischof, C.—Versuch einer Zusammenstellung der Deutschen und der Bekanntesten Fremden Thone nach den Formationen, etc. *Dingler's Polytech. Jour.*, **206,** 295–303 (1872).

Bischof, C.—Pyrometrische und Analytischen Untersuchung eines gelben und rothen Ziegellehmes. *Dingler's Polytech. Jour.*, **211,** 128–33 (1874).

Bischof, C.—Neues Kaolinvorkommen bei Göppersdorf, dessen Pyrometrisches Verhalten, nebst chemischer Analyse des Rohen wie Geschläm-

ten Materials. *Dingler's Polytech. Jour.*, **213**, 60–3 (1875). (Abs. *Quart. Chem. Soc.*, **13**, 433–4 (1875).)

Bischof, C.—Untersuchung von zwei zu Znaim (Mähren) Vorkommenden Kaolinen. *Dingler's Polytech. Jour.*, **214**, 434–8 (1877).

Bischof, C.—Analyses of Bauxite. *The Metallurgical Review*, **2**, 523 (1878). (Abs. from *Berg.-und Hüttenmännische Zeitung*, p. 196 (1878).)

Bischof, C.—Die Thone aus Bayern. (1883).

Bischof, C.—Fire Clay from Wildstein. *Sprechsaal*, **25**, 193; *Jour. Iron and Steel Inst.*, **2**, 343 (1892).

Bischof, C.—Gesammelte Analysen der in der Tonindustrie Benutzten Mineralien (1901).

Bischof, C.—Die feuerfesten Tone. 4th Ed. (1923).

Bley, L. F.—Chemische Untersuchung einer Porcellanerde von dem Gute Gutenberg unweit Halle a. S. *Jour. prakt. Chemie*, **5**, 313 (1885).

Blomstrand, C. W.—Zur Frage über die Hainstädter Thone. *Jour. für prakt. Chemie*, **33** [2], 483–8 (1886). (Abs. in *Berichte*, **19**, 389 (1886).)

Blum.—Pseudomorphosen, a. Hauptband, 1843. (Kaolin, Passau.) *Nachtrag*, **1** (1847); **2** (1852); **3** (1863); **4** (1879).

v. Braunmühl.—Mitteilungen über den Neuroder Schieferton. *Ber. über die 31, ord. Hauptvers. d. V. deutscher Fabriken feuerfester Produkte*, 71–80 (1911). (Abs., *Geol. Centralb.*, **16**, 668 (1911).)

Brongniart, A.—Über Porcellanerde, etc. (Kaolin in Saxony). *Bull. Soc. Geol. France*, **10**, 56 (1839); *Comptes Rendus*, **7**, 1085; *Jour. Prakt. Chemie*, **17**, 118 (1839); *Archiv. d. mus. d' Hist. Nat.*, **8**, 446 (1840).

Brongniart, A.—Zweite Denkschrift über die Kaoline oder Porzellanerden, über die Natur und den Ursprung derselben. *Poggendorff. Annalen*, **60**, 129 (1843).

Bruhns.—Die Nutzbaren Mineralien und Gebirgsarten im Deutschen Reiche (1906).

Clark, W. S.—Analyse von Kaolin von Schneckenstein. *Annal. Chem. Pharm.*, **80**, 122 (1851) and *Jahresber. Chem.*, p. 786 (1851).

Cobenzi, A.—A Noteworthy Deposit of Kaolin at Neckarsteinach. *Chem. Zeit.*, **46**, 334–5 (1922); *Keram. Runds.* **30**, 202 (1922).

Cramer, E.—Feuerfeste Thone und Quartzite. *Chemiker Zeit.*, **25**, 201–2 (1901).

Credner, G. R.—Die Krystallinischen Gemengtheile gewisser Schieferthone und Thone. *Zeitschr. für gesam. Naturwiss.* (Abs., *Jahrbuch für Mineral*, pp. 423–4 (1875).)

Dalmer, K.—Erläuterungen zur geologischen Specialkarte des Königreichs Sachsen. Section Schneeberg (6).

Dammer, B.—Beitrage zur Kenntnis einiger Kaolinlagerstätten. *Zeit. f. prakt. Geol.*, **11**, 357–8 (1903). (Abs., *Geol. Centralb.*, **6**, 269 (1905).)

Drechsler, E.—Analyse des Bauxites aus des Wochein. *Dingler's Polytech. Jour.*, **203**, 479–81 (1872).

Ebermayer.—Über feuerfesten Thon und Sand aus der Keuper-Formation bei Coburg. *Berg. und Hüttenmännische Zeit.*, **20**, 209 (1861).

Ehrenberg, C. G.—(Kaolin at Aue, Saxony.) In paper on: Über die organischen Formen Gewisser. *Mineralien. Berlin Akad.*, **18**, Aug. (1836).

Endell, K.—Über die Entstehung der Porzellanerde aus basischen Eruptivgesteinen. *Sprechsaal*, **43**, 278–80. (Abs., *Geol. Centralb.*, **17**, 586 (1911–12).)

Fiebelkorn, M.—Geologische Ausflüge in die Umgegend von Berlin (1896).

Fiebelkorn, M.—Die Entstehung unserer Thongesteine (Aus "Baumaterialienkunde"), 39 pp. (1900).

Fiebelkorn, M.—Die Tone des norddeutschen Flachlandes und ihre Verarbeitung, mit besondere Berücksichtigung der Herstellung und Ver-

wendung von Portlandzement. *Brandenburgia*, **12** [7], 237–57 (1903). (Abs., *Geol. Centralb.*, **13**, 509 (1909–10).)

v. Flurl.—Kaolin at Passau. *S. Köhler's Bergmänn Journal*, **2**, 532 (1790).

Freise, F.—Clays of the Westerwald. *Zeits. für prakt. Geologie*, **16**, 162–5. (Abs. in *Jour. Iron and Steel Inst.*, **76** [1], 251 (1908).)

Freiesleben.—Kaolin at Aue, Saxony. *Geognost. Arbeiten, Magaz. f. Oryktographie von Sachsen*, **1**, 83 (1830).

Fresenius, R.—Chemische Untersuchung einiger der Wichtigsten Nassauischen Thone. *Jour. für prakt. Chemie*, **57**, 65–80 (1852).

Fuchs, J. N.—Über die Entstehung der Porzellanerde Mineralogisches Taschenbuch für Jahr 1823. Von Karl C. R. von Leonhard, **17**, I, Abth., 94–128 (1823).

Gehler, A. F.—Kaolin near Passau. *Schweigger's Jour. f. Chemie und Physik*. **1**, 447 (1811).

Gehler, A. F.—Kaolin near Passau. *Moll's Ephem. d. Berg. und Hüttenk.* **2**, 321.

Gehler, A. F.—Über das Vorkommen u. die Gewinnung der Porcellanerde im ehemaligen Furstenthum Passau, 1811.

Gericke, C.—Über die Gaugthonschiefer in den Erzgäugen des Nordwestlichen Aberharzes. (Inaugural-Dissertation an der Universität Göttingen.) (Analyses of Clay Shales) (1868).

Glocker, E. F.—Kaolin in Mähren. Mineralogisches aus Schlesien und Mähren. *Isis*, **23**, 1084 (1830).

Groddeck, A. von.—Studien über Thonschiefer, Gangthonschiefe und Sericitschiefe (Clay Slate and Sericite Slate). *Jahrbuch k. preuss. Geol. Landesanstalt für, 1885*, 1–52. (Abs. in *Jahrbuch für Mineral*, **1**, 415–7 (1888).) (Abs. in *Jour. Chem. Soc.*, **54**, 795 (1888).)

Gümbel, C. W.—Verzeichnis der in der Oberpfalz vorkommenden Mineralien Korrespondenzbl. *Zoöl. Min. Ver. Regensburg*, **7**, 151 (1853).

Gümbel, C. W.—Nakrit aus dem Kohlengebirge der Rheinpfalz. *Neues Jahrb.*, p. 385 (1878).

Häberle, D.—Die Tonlager der Rheinpfalz und ihre Industrie. *Der Steinbruch*, 1918 u. 1919, **13** u. **14**, Jahrg., No. 47–52 u. No. 1–2; also *Mitt. u. Arbeiten a. d. Geologischen Institute der Univ. Heidelberg, N. F.* No 33. *Berlin, Union Deutsche Verlagsgesellschaft*, 1919. (Abs., *Geol. Centralb.*, **24**, 69 (1919–20).)

Häberle, D.—Die keramische Industrie der Rheinpfalz. *Bayerischer Heimatschutz*, 17, Jahrg., 1919 (auch Bayerischer Heimgarten 1919–20), 36–41. (Abs. *Geol. Centralb.*, **24**, 172 (1919–20).)

Hauer, K. R. von.—Arbeiten, Ausgeführt im Chemischen Laboratorium der k. k. Reischsanstalt. *Jahrbuch* (Fire Clay), **11**, 285 (1860); (Clay, Kaolin, Feldspar), **13**, 147, 148, 475 (1863); (Clay Analyses), **14**, 139 (1864); (Kaolin), **14**, 304 (1864).

Hauer, K. R. von.—Kaolin and Clay Analyses. *Jahrbuch k. k. Geol. Reichsanstalt*, **9**, 172, 696 (1858), **11**, 285 (1860); **13**, 147–8 (1863); **14**, 139, 304 (1864); **19**, 428, 430, 433 (1869).

Hauer, K. R. von.—Kaolin von Budweis, Feuerfester Thon von Rév., etc. Porcellanerde. (Analyses.) *Jahrbuch k. k. Geol. Reichsanstalt*, **19**, 428, 32 (1869).

Hauer, K. R. von and Conrad, J.—Arbeiten in dem Chemischen Laboratorium der k. k. Geol. Reichsanstalt. (Clay Analyses.) *Jahrbuch*, **25**, 141–206 (1875).

Herold, H.—Über die Kaoline der Formation des Mittleren Buntsandsteins in Thüringen. *Inaug. Dissert.* (1875). (Abs. in *Jahrb. für Min.*, 1875, p. 876 and *Jour. Chem. Soc. London*, **1**, 530 (1876).)

Herrman, O.—Section Klaster St. Marienstern. (Kaolin near Lansitz.) *Erläuterungen zur geol. Specialkarte des Königreichs Sachsen*, No. 37 (1892).

Herrman, O.—Section Welka-Lippitsch. (Kaolin, Lausitz.) *Erläuterungen zur geol. Specialkarte des Königreichs Sachsen*, No. 23 and 28 (1893).

Herzberg, W.—Feuchtigkeitsgehalt des Kaolins. *Mitt. Tech. Versuchsanst.*, **20,** 336 (1902).

Höchst, J.—Das Vorkommen von plastischen Thon im Bergmeistereibezirk Diez. *Odernheimer, das Berg-und Hüttenwesen im Herzogthum Nassau*, Pt. 3, pp. 464–71.

Humperdink.—Über die Kaolinlager aus der Gegend von Halle. *Vertrag. Vers. deutsch. geol. Ges.* (1901). (Abs., *Zeits. f. prakt. Geol.*, p. 419 (1901).)

John, C. von.—Analysen aus dem Chemischen Laboratorium k. k. Geol. Reichsanstalt (Clay Analyses). *Jahrbuch k. k. geol. Reichsanstalt*, **42,** 172 (1892).

John, C. von and Foullan, H. B. von.—Arbeiten aus dem Chemischen Laboratorium der k. k. geol. Reichsanstalt (Analysen der Thone). *Jahrbuch*, **31,** 508 (1881); **36,** 348, 349 (1886); **38,** 630 (1888).

Kaul, H.—Geologisch Chemische Studien über die Thone und Lehmvorkommen um Nürnberg. *Inaug.-Diss. Erlangen*, 1900.

Kilroe, J. R.—On the Occurrence and Origin of Laterite and Bauxite in the Vogelsberg. *Geol. Mag.*, **5,** 534–42 (1908).

Kossmann.—Feuerbeständige plastische Thone aus Ober-und Niederschlesien. *Dingler's Polytech. Jour.*, **256,** 276 (1885).

Kossmann.—Kaolin in the Coal Measures of Germany. *Zeits. deutsch. geol. Gesell.*, **45,** 173–5 (1893).

Kraatz, K. von.—Die Ziegelthone von Braunschweig. *Zeits. f. prakt. Geol.*, pp. 409–11 (1897).

Kühn, O. B.—Analyse des Kaolins von Aue bei Schneeberg. *Schweiger's Jahrb. d. Chemie*, Pt. 9, p. 34 (1829).

Lang, J.—Über Bauxit von Langsdorf. *Bericht der Deutschen Chemischen Gesell.*, **17,** 2892–4 (1884). (Abs., *Neues Jahrb. f. Min.*, **11,** 342 (1886) and *Jour. Iron and Steel Inst.*, **1,** 293 (1886).)

Lang, J.—Über Kaolinit in Sandsteinen des Schwäbischen Mittleren Keupers. *Zentralbl. f. Min. usu.*, p. 596 (1909).

Lang, R.—Entstehung von Braunkohle und Kaolin im Tertiar Mitteldeutschlands (1921).

Lapparent, A. de.—Revue de géologie. (Kaolin in Thuringia.) *Annal. de Min.*, **18** [7], 364 (1877).

Lasaulx, A. v.—Pholerit und feuerfeste Thone von Neurode. *Sitzungsber. Niederrhein. Ges. Natur-u. Heilk.*, **43,** 10 (1886).

Laspeyres, H.—Blatt Petersberg (Kaolin). *Erläuterungen zur Geologischen Karte von Preussen*, 1874, No. 263.

Liebrich, A. v.—Bauxit. *Bericht der Oberhess. Gesellschaft für Natur. und Heilkunde*, **28,** 57–98.

Liebrich, A. v.—Beitrag zur Kenntnis des Bauxits von Vogelsberge. *Inaug. Dissert.* (1891).

Lincke, R.—Der Buntsandstein am Ostrande des Thüringer Beckens. (Kaolin, Thüringia.) *Neues Jahrb.*, 1871, p. 23.

Loretz, H.—Blatt Steinheid. (Kaolin Thuringia.) *Erläuterungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten.* Gradabteilung, **70,** No. 35 (1885).

Ludwig, R.—Bildung von Lehm, Thon aus Zersetztem Dolerit und Basalt. *Jahresber. Chemie*, p. 831 (1851).

Mathias, W.—The Clay and Loam Deposit at Hettenleidelsheim, in the Palatinate. *Zeits. f. prakt. Geol.*, pp. 133–44 (1920). (Abs. in *Jour. Iron and Steel Inst.*, **103,** 377 (1921).) (Abs., *Geol. Centralbl.*, **25,** 488 (1920–21).)

von zur Muhlen, L.—Kaolin and Kaolinized Granite in the District between Strobel and Saarau, Silesia and Their Formation. *Zeit. f. prakt. Geol.*, pp. 56–61 (1921).

Müller, L.—Das Kaolin und seine deck-

enförmigen Lagerstätten in Mittel-Deutschlands. *Der Steinbruch.*, pp. 79–80 (1910). (Abs., *Geol. Runds.*, p. 180 (1911).)

Pagels.—Feuerfester Thon bei Polnisch-neudorf. *Wochenschrift des Schlesischen Vereins für Berg-und Hüttenwesen.*, No. 4 (1861). (Abs. in *Dingler's Polytech. Jour.*, **159,** 238 (1861).)

Pollak, O.—Porzellanerde von Brenditz nächst Znaim. *Jahrbuch k. k. Reichsanstalt*, **3,** 162 (1852).

Prziwoznik, E.—Analyses of Bauxite. Berg.-u. Hüttenmännisches. *Jahrbuch der k. k. Bergakademien*, **15,** 564 (1865); **38,** 415, 416 (1888).

Randhahn, K.—Contribution to the Knowledge of Bunzlau Clay. Dissertation, 1907.

Rasel.—Die Oberpfälzer Kaolinindustrie. *Diss. Erlangen*, 1909.

Reinhold, T.—Eigenschappen en Samenstellung van einige Limburgsche Kleisoorten, Benevens de Bepaling van het Smeltpunt. *Polytechnisch Weekblad.*, **12** [47, 22], 523–26 (1918). (Abs., *Geol. Centralb.*, **24,** 172 (1919–20).)

Rieke, R.—Kaolin. *Sprechsaal*, **40,** 33 (1907).

Rieke, R.—The Replacement of English Kaolin (China Clay) by Domestic Materials. *Sprechsaal*, **48,** 183–5, 191–3, 199–201 (1915).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *Ann. Rept., Pt. VI (cont.)*, **19,** 411–35 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *Ann. Rept., Pt. VI (cont.)*, **21,** 382–4 (1901).

Rohland, P.—German and English Kaolins. *Papier Zeit.*, **39,** 2658 (1914).

Rösler, H.—Beitrag zur Kenntnis einiger Kaolinlagerstätten. *Neues. Jahrb. f. Min., Beil. Bd.*, **15,** 231–393 (1902). (Abs., *Geol. Centralb.*, **7,** 329 (1905–06).)

Sachs.—Bodenschätze Schlesiens (1906).

Sauer.—*Erläuterungen zur Geol. Specialkarte, Section Liebertwolkurtz. Rotha*, p. 45 (1905).

Schafhäutl.—Kaolin in Passau. *Corr.-Blatt. zoöl.-min. Ver.*, **2,** 118.

Schmid, E. E.—Die Kaoline des Thüringischen Buntsandsteins. *Zeits. deutsch. Geol. Gesell.*, **28,** 87–110 (1876). (Abs., *Jahrb. für Min.*, pp. 669–79 (1876); *Jour. Chem. Soc. London*, **2,** 119–20 (1877); *Ann. des Mines*, Ser. 7, **13,** 365–6 (1878).)

Schmitz, Ch.—Kaolin near Passau. *K.- und Gew.-Blatt*, p. 242 (1883).

Seemann.—Über die Ton-und Kaolingrubenindustrie westlich und südwestlich von Meissen. *Jahrb. f. d. Berg.- u. Hüttenwesen im Kgr. Sachsen*, pp. 3–24 (1902). (Abs., *Geol. Centralb.*, **4,** 686 (1904).)

Seger, H.—Über die Beziehungen zwischen der Zusammensetzung der Sennewitzer Kaoline und deren Verhalten im Feuer. *Ges. Schriften*, p. 527.

Seger, H.—Analyses of Clays from Breitscheid, Germany. *Stahl und Eisen*, **20,** 500.

Seger, H.—Untersuchung des Thones von Löthain. *Dingler's Polytech. Jour.*, **248,** 185 (1883). (Abs., *Jour. Chem. Soc.*, **44,** 627 (1883).)

Seger, H.—Analysirte Meissener Kaoline. *Dingler's Polytech. Jour.*, **256,** 277 (1885).

Seger, H.—Gesammelte Schriften, 908 pp. (1896).

Selle.—Über Verwitterung und Kaolinbildung Hallescher Quarzporphyre. *Zeits. f. Naturw.*, **79,** Pt. 5 and 6 (1907).

Sillem.—Über Pseudomorphosen. (Kaolin near Passau.) *Neues Jahrb.*, p. 389 (1851); p. 535 (1852).

Stahl, A.—Die Verbreitung der Kaolinlagerstatten in Deutschland. *Archiv. für Lagerstätten K. Preussischen Geol. Landesanstalt*, **12** (1912).

Stahl, A.—The Distribution of Kaolin Deposits in Germany. *Tonind. Zeit.*, **37,** 663–5.

Stahl, A.—Die Verbeitung der Kaolin-

lagerstätten in Deutschland. Diss., Berlin (1911). (Abs., *Geol. Centralb.*, **17,** 587 (1911–12).)

Steinberg, C.—Chemische Untersuchung Mehrerer Sorten Porcellanerde aus der Nähe von Halle a. S. *Jour. prakt. Chemie.*, **16,** 51 (1839).

Stremme, H.—Über die Beziehungen einiger Kaolinlager zur Braunkohle. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, **2,** 91–121 (1909).

Stremme.—Über Kaolinbildung im allgemeinen und die Entstehung der Lausitzer Kaolinlagerstätte im besonderen. *Sprechsaal* (1909).

Stutzer, O.—Die Weiss Erden-zeche St. Andreas bei Aue. *Zeits. f. prakt. Geol.*, **13** [9], 333–7 (1905). (Abs., *Geol. Centralb.*, **7,** 635 (1905–06).)

Tannhaüser, F.—Zur Entstehung der Neuroder feuerfesten Schiefertone in der Grafschaft Glatz. *Zeits. f. prakt. Geol.*, **17,** 522–4 (1909).

Tietze, E.—On Fire Clays. *Jahrb. k. k. Reichsanstalt*, **2,** 317–30.

Tietze, O.—Das Steinkohlengebirge von Ibbenbüren. *Jahrb. K.-preuss. geol. Landesanstalt*, **29,** 349 (1912).

Vasei, A.—The Quantity and Composition of Colloid Clay in Kaolin from Meissen, *Kolloid-Zeit.*, **33,** 178–80 (1923).

Vohl, H.—Analyse einer Thonsorte von Klingenberg. *Dingler's Polytech. Jour.*, **199,** 496 (1871).

Voigt, J. C. W.—Kleine Mineralogische Schriften. (Kaolin, Thüringia.) Weimar, **2,** 130 (1800).

Waltl.—Porcellanerde bei Passau. *Schluprogramm* (1853) and (1862); and *Corr.-Blatt. zoöl.-min. Ver., Regensburg*, **2,** 78.

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13,** 228 (1911).

Weinschenk, E.—Beiträge zur Mineralogie Bayerns. (Kaolin near Passau.) *Zeit f. Krystallogr.*, **28,** 152 (1897).

Weinschenk, E.—Die Graphitlagerstätten des bayerischböhmischen Grenzgebirges. (Kaolin Passau.) *Abhandl. k. bayer. Akad. Wiss.*, **2** [19], 16 (1897).

Weiss, F.—Vorkommen und Entstehung der Kaolinerden des ostthüringischen Buntsandsteinbeckens. *Zeit. f. prakt. Geol.*, **18,** 353–67 (1910). (Abs., *Geol. Centralb.*, **16,** 1087 (1911).)

Weisz, F.—Review of Paper on Kaolins of East Thuringia. *Keram. Runds.*, **19,** 19 (1911).

Wineberger.—Versuch einer geognostischen. Schilderung des bayerischen Waldgebirges (Kaolin Passau.) p. 73 (1851).

Winkler, M.—Beitrag zur Geschichte der Kaolingruben der Königl. Porzellan-Manufaktur zu Meissen. *Jahrb. f. d. Berg.-u. Hüttenwesen im Kgr. Saschsen*, 129–34 (1902). (Abs., *Geol. Centralb.*, **4,** 686 (1904).)

Wirst, E.—Die Enstehung der Kaolinerden der Gegend von Halle a. S. *Zeits. f. prakt. Geol.*, **15,** 19–23 (1907).

Great Britain

Anon.—Bath Brick. *Chamb. Jour.*, **73,** 21–3 (1896).

Anon.—Kaolin Deposits of Cornwall. *Bull. Imp. Inst.*, **18,** 283–8 (1920). Notes based on articles by H. F. Collins in the *Mining Mag.* and on the Hensbarrow Granite District by J. H. Collins and on A Handbook to the Collections of Kaolin, China Clay and China Stone in the Museum of Practical Geology, Jermyn St., London, by J. Allen Howe.

Anon.—Brick Earths of Great Britain. *British Clayworker*, **9** (1900–01). (Abs., *Geol. Centralb.*, **1,** 741 (1901).)

Anon.—Some Yorkshire Claypits. *Quarry*, **5,** 515–24. (Abs. *Geol. Centralb.*, **1,** 294 (1901).)

Anon.—Pottery Clay in Tyrone. *British Clayworker*, **11,** 164 (1902–03).

Anon.—China Clay from Antrim. *British Clayworker*, **14,** 22 (1905–06).

Anon.—China Clay in Antrim. *British Clayworker*, **16,** 107 (1907–08).

Anon.—Coal and Fire Clay at Ballycastle. *British Clayworker*, **16,** 91 (1907–08).

Anon.—Irish Clays. *The British Clayworker*, **28,** 22 (1919–20).

Anon.—Brick Earths of Great Britain. *British Clayworker*, **10** (1901–02). (Abs., *Geol. Centralb.*, **3,** 207 (1903).)

Anon.—Reported Discovery of China-Clay near Wrexham. *British Clayworker*, **13,** 247 (1905).

Anon.—China Clay and China Stone of St. Austell. *The British Clayworker*, **18,** 311 (1909–10).

Anon.—South Devon Clays. *The British Clayworker*, **18,** 146 (1909–10).

Anon.—Cornwall and Devon Clays. *British Clayworker*, **19,** 128 (1910–11).

Anon.—Summary Rept. of Progress of the Geol. Surv. of Gr. Brit. for 1916. Abs. in *Jour. Iron and Steel Inst.*, **97** [1], 475 (1918).

Anon.—English China Clay for Hard Porcelains. *Pottery Gaz.*, **45,** 513 (1920).

Anon.—China Clay (Cornwall, Eng.). *Chem. Age*, **8,** 15 (1923).

Atkinson, J. B. and Stobbs, J. T.—The Geology of the Refractory Materials of the North of England. *Trans. Eng. Ceram. Soc.*, **18,** 435 (1919).

Ball, L. C.—China Clay as Worked in Cornwall. Queensland, *Govt. Mining Jour.*, p. 219 (1909).

Barrett, C. R. B.—Somersetshire: Highways, Byways and Waterways (1894).

Barrow, G.—The Geology of the Country around Padstow and Camelford. *Mem. Geol. Surv.* (1910).

Blackwell, G. G.—Bauxite. *Trans. Manchester Geol. Soc.*, **22,** 525–7 (1894).

Boase, H. S.—Contributions towards a Knowledge of the Geology of Cornwall. *Trans. Royal Geol. Soc.*, **4,** 235 (1832).

Bodin, V.—China Clay. *Science et Industrie*, **7** [108], 134–6 (1923).

Boulton, W. S.—Fire Clays of South Staffordshire. *Trans. of Eng. Ceram. Soc.*, **16,** 237–58 (1916–17). (Abs. in *Jour. Iron and Steel Inst.*, **98** [2], 438 (1918).)

Bulman, G. W.—Underclays: A Preliminary Study. (The Clays Underlying Coals.) *Geol. Mag.*, **9,** 351–61 (1892).

Burton, R. C.—Formation of Kaolinite in Some Coal-measure Shales of Northumberland. *Proc. Univ. Durham Phil. Soc.*, **4,** 24–9 (1911).

Butler, F. H.—Über Kaolin (Deals with Origin of Kaolinite in the Coal Measures of Glamorganshire, England). *Centralblatt für Mineralogie, Geologie und Paläontologie*, p. 426 (1911).

Cameron, A. C. G.—On the Continuity of the Kellaways Beds over Extended Areas near Bedford, and on the Extension of the Fullers' Earth Works at Woburn. *Rept. Brit. Assoc. Adv. Sci., 1891*, p. 636 (1892).

Cameron, A. C. G.—The Fullers' Earth Mining Company at Woburn Sands. *Geol. Mag.*, **9,** 469 (1892).

Church, A. H.—Red Chalk and Red Clay. *Chem. News*, **31,** 199 (1875). (Abs., *Jour. Chem. Soc.*, **13,** 872 (1875).)

Cock, D.—A Treatise on China Clay (1880).

Cock, D.—A Treatise, Technical and Practical on the Nature, Production and Uses of China Clay, with Several Useful Tables and Statistics Bearing on the Subject, 151 pp. (1880).

Cole, G. A. J.—The Rhyolites of the County of Anthrim [Ireland], with a Note on Bauxite. *Sci. Trans. Roy. Dublin Soc.*, Ser. II, **6,** 105–9 (1896).

Collins, H. F.—The China Clay Industry of the West of England. *Mining Mag.*, **21,** 269–75, 329–37 (1919) and **22,** 25–32, 94–7 (1920). (Abs. in *Bull. Imp. Inst.*, **18,** 283–8 (1920).)

Collins, H. F.—China Clay, Its Composition, Preparation and Uses. *Chemistry and Industry*, **42,** 88–91, 114–7 (1923).

Collins, J. H.—On China Clay and China Stone of Devon and Cornwall. *Jour. Soc. Arts*, **24,** 565–72 (1876).

Collins, J. H.—The Hensbarrow Granite District (1878).

Collins, J. H.—The China Clay Industry of Cornwall and Devon. *Popular Science Review, Littell's Living Age,* 434–8 (1878).

Collins, J. H.—Notes on China Clay and its Uses. *English Mechanic and World of Science,* **43,** 385 (1886).

Collins, J. H.—On the Nature and Origin of Clays. The Composition of Kaolinite. *Mineral. Mag.,* **7,** 205–14.

Collins, J. H.—Kaolin, or China Clay. *Eng. and Min. Jour.,* **79,** 1079–80 (1905).

Collins, J. H.—The China Clay Industry of Cornwall. *The Mining Magazine,* **4,** 449 (1911).

Collins, J. H.—Notes on Some Geological Features at the Carpalla China Clay Pit in the Parish of St. Stephen's, Cornwall. *Quart. Jour. Geol. Soc.,* **65,** 155 (1909).

Coon, J. M.—China Clay. *Trans. Eng. Ceram. Soc.,* **10,** 82 (1911).

Coon, J. M.—The Bloomdale China Stone and Clay Coy. *Trans. Eng. Ceram. Soc.,* **11,** 13 (1912).

Coon, J. M.—On China Stone, Cornish Stone or Petunzyte. *Trans. Royal Geol. Soc., Cornwall,* **8** [9], 561 (1913).

Cox, A. H.—Notes on Some South Staffordshire Fire Clays and Their Behavior on Ignition. *Geol. Mag.,* **6, 5** [644], 56–63 (1918). (Abs., *Geol. Centralb.,* **26,** 454 (1921).)

Davies, D. C.—The Fire Clays and Fire Clay Productions of North Wales. *British Architect,* Jan. 21 and Jan. 28 (1877).

Davies, D. C.—Earthy and Other Minerals and Mining, pp. 38–58 (1888).

Dewey, H.—The Refractory Materials of the London Basin. *Trans. Eng. Ceram. Soc.,* **22,** 38 (1923).

Dewey, H.—The Geology of the Bournemouth District. *Trans. Eng. Ceram. Soc.,* **22,** 293 (1923).

Ennos, F. R. and Scott, A.—Refractory Materials of Great Britain. Brit. Geol.-Surv. Special Rept., *Min. Res. Gr. Br.,* No. 28 (1924).

Etheride, R.—On the Occurrence of a Large Deposit of Terra Cotta Clay at Watcombe, Torquay. Abs. of paper before Brit. Assoc. at Exeter. *Ann. Scientific Discovery,* pp. 258–9 (1870).

Farie, J.—Notes on Pottery Clays: The Distribution, Properties, Uses and Analyses of Ball Clays and China Stone (1901).

Fearnsides, W. G.—Native Supplies of Refractory Materials Available in the Sheffield District. *Trans. Eng. Ceram. Soc.,* **18,** 280 (1918).

Firth, E. M., Hodkin, F. W. and Turner, W. E. S.—The Composition, Drying and Firing Shrinkage, Porosity and Sensity of British Fire Clays Suitable for Glass Furnace Refractory Material. *Jour. Soc. Glass Technology,* **4,** 162–204 (1920).

Fitton, W. H.—Porcelain Earths of Cornwall. *Ann. Phil.,* **3,** 180 (1814).

Flett, J. S.—The Geology of the Country around Bodmin and St. Austell. *Mem. Geol. Surv.,* p. 65 (1909).

Fryar, M.—Iron Ore and Fire Clay, Their Geological Formation and Methods of Working. *Lectures Delivered at Bristol Mining School, 1857,* pp. 290–300 (1859).

Garnett, C. S.—The "Toadstone Clays" of Derbyshire. *Mineralog. Mag.,* **20,** 151–7 (1923).

Gilligan, A.—The Lower Permian at Ashfield Brick and Tile Works, Conisborough. *Proc. York. Geol. Soc.,* **19,** 289–97 (1918).

Green, A. H.—Physical Geology. 3rd Ed, 1882. (8 Analyses of Typical Kaolin, p. 174. Clay of Organic Origin, p. 233.)

Gregory, J. W.—*Nature,* **80,** 148. (Abs. in *Jour. Iron and Steel Inst.,* **80** [2], 348 (1909).)

Gregory, J. W.—Glenboig Clay. *Proc. Royal Soc. of Edinburgh,* **30,** 348–60. (Abs. in *Jour. Iron and Steel Inst.,* **82** [2], 409 (1910).)

Gregory, J. W.—The Fire Clay of Glenboig, Lamarkshire. *Proc. Roy. Soc. Edin.*, **30,** 348–60 (1910).

Hambley and Spillers.—Analyses of Bricks, Clays and Porcelain Clays of Glasgow. *Chem. Gazette,* p. 100 (1856); *Chemisches Central-Blatt.*, p. 590 (1856).

Hinxman, L. W. and MacGregor, M.—The Distribution and Geological Position of the Valuable Fire Clays and Ganisters of the South of Scotland. *Trans. Eng. Ceram. Soc.*, **17,** 35 (1917–18).

Hinxman, L. W. and MacGregor, M.—Fire Clays and Ganisters of the South of Scotland. *Pottery Gaz.*, **42,** 1070 (1917).

Holland, P. and Dickson, E.—Remarks on the Formation of Clay. *Proc. Liverpool Geol. Soc.*, Pt. 1, **7,** 108–17 (1892).

Holland, T. H.—On the Constitution, Origin and Dehydration of Laterite. *Geol. Mag.*, **10,** 59–69 (1903).

Howe, J. A.—Notes on the Refractory Materials of South Wales. *Trans. Eng. Ceram. Soc.*, **18,** 27–42 (1919). (Abs. in *Jour. Iron and Steel Inst.*, **99** [1], 626 (1919).)

Hutchings, W. M.—Further Notes on Fire Clays etc. *Geol. Mag.*, p. 164, April, 1891.

Jackson, W. and Richardson, A. G.—The Clay Deposits of Cornwall and Devon. *Trans. Eng. Ceram. Soc.*, **3,** 44 (1905).

Jones, W. R. R.—Refractory Silica Materials of South Wales, with Special Reference to the Influence of Texture. *Trans. Eng. Ceram. Soc.*, **21,** 358–93 (1921–22).

Keeling, F. A.—Pike Bros. Dorset Clay Mines. *Trans. Eng. Ceram. Soc.*, **11,** 19 (1912).

Macadam, W.—Analyses of Samples of China Clay (Kaolinite), Cornwall. *Mineralogical Mag.*, **7,** 76 (1887).

MacAlister, D. A.—Summary of Progress for 1905. *Mem. Geol. Surv.*, p. 34 (1906).

Mac Alister, D. A., Usher, W. A. E., Barrow, G. and Flett, J. S.—The Geology of the Country around Bodmin and St. Austell. *Mem. Geol. Surv.* (1909).

Maw, G.—The Distribution beyond the Tertiary Districts of White Clays and Sands Subjacent to the Boulder-Clay Drifts. *Geol. Mag.*, **4,** 241–51, 299–307 (1867).

Maw, G.—Catalogue of Specimens Illustrating the Clays and Plastic Strata of Great Britain. *Appendix A to Catalogue of Specimens in the Museum of Practical Geol.*, pp. 213–52 (1871).

Maw, G.—The Source of the Materials Composing the White Clays of the Tertiaries. *Quart. Jour. Geol. Soc., London,* **23,** 387–94.

McDonald, D. P.—Glenboig Fire Clay. Paper read before Royal Soc. of Edinburgh. (Abs. in *The British Clayworker,* **19,** 14 (1910–11).)

Page, E. P. and Rees, W. J.—*Eng. Times,* **15,** 216 and 248–9. (Abs. in *Jour. Iron Steel Inst.*, **43** [1], 383 (1907).)

Quick, J.—Cornish China Clay. *Quart. Sci.*, **14,** 500–12 (1877); *Mining Journal, August,* p. 425 (1891).

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 402–10 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, **21,** 384–5 (1901).

Roberts, T.—The Upper Jurassic of Lincolnshire. *Quart. Jour. Geol. Soc.*, **45,** 543 (1889).

Sanford, P. G.—An Analysis of Fullers' Earth of Nutfield. *Geol. Mag.*, pp. 455–6 (October, 1889).

Sanford, P. G.—Analysis of Fullers' Earth of Urongoch, Near Bola, N. Wales. *Geol. Mag.*, April, p. 160 (1893).

Sargent, H. C.—On the Origin of Certain Clay-bands in the Limestone of the

Crich Inlier. *Geol. Mag.*, **9**, 406 (1912).

Scrivenor, J. B.—The Kaolin Veins. *Geol. Mag.*, **6, 5** [644], 79–82 (1918). (Abs., *Geol. Centralb.*, **26**, 395 (1921).)

Searles, A. B.—An Introduction to British Clays, Shales and Sands (1912).

Sortwell, H. H.—American and English Ball Clays. Bur. Standards, *Tech. Paper*, **17** [227], 153–82 (1923).

Sortwell, H. H.—The Properties of Some Ball Clays. *The Ceramist*, **2** [1], 5–15 (1922).

Stobbs, J. T.—Clays and Marls of North Staffordshire, *Pottery Gaz.*, **42**, 155 (1917); also *Trans. Eng. Ceram. Soc.*, **16**, 107 (1916–17).

Stoker, H. M.—China Stone and China Clays of Cornwall. *Jour. Soc. Arts*, **1**, 498–501 and 509–12 (1853). From the *Jour. Roy. Cornwall Polytechnic Soc.* (*20th Ann. Rept.*).

Taylor, H.—On the Chemical Constitution of the Rocks of the Coal Formation. (Analyses of Clays.) *Edinburgh Philos. Jour.*, **50**, 140 (1850–51). (Abs. in *Neues Jahrb. für Min.*, p. 329 (1852).)

Thomas, C. W.—The Composition of British Fire Clays. *The British Clayworker*, **30**, 21 (1921–22).

Thompson, B.—Some Clay Beds by the Ouse. *Geol. Mag.*, **4**, 24 (1907).

Timmis, G. H.—Preparation and Properties of Fire Clay with Special Reference to the Stourbridge Pot Clay. *Trans. Eng. Ceram. Soc.* (*Refractory Mat. Sec.*), **16**, 197–204 (1916–17). *Iron and Coal Trades Rev.*, **94**, 635 (1917). (Abs. in *Jour. Iron and Steel Inst.*, **96** [11], 353 (1917).)

Trechmann, C. T.—A Deposit of Interglacial Loess, and Some Transported Preglacial Clays of the Durham Coast. *Quart. Jour. Geol. Soc.*, **75**, 173–203 (1920).

Wagstaffe, E. A.—*Jour. Soc. Chem. Ind.*, **25**, 101–3. (Abs. in *Jour. Iron and Steel Inst.*, **73** [1], 383 (1907).)

Watts, A. S.—Clay and Kaolin Mining in Europe. *Trans. Amer. Ceram. Soc.*, **13**, 238 (1911).

Wilson, G. V.—The Ayrshire Bauxitic Clay. *Memoirs Geol. Surv. Scotland*, 1922.

Wilson, W.—On the Fire Clay Manufacture of Scotland. *Van Nostrand's Mag.*, **9**, 353–60. *Proc. Edinburgh and Leith Eng. Soc. Iron World and Manufacturer* (1873).

Woodward, H. B.—Geology of England and Wales, p. 371. (Fullers' earth.)

Worth, R. H.—China Clay. The Geology of the Country around Ivybridge and Modbury. *Mem. Geol. Surv.*, p. 121 (1912).

Wright, W. B.—Age and Origin of the Lough Neogh Clays. *Quart. Jour. Geol. Soc.*, **80**, 486–8 (1924).

Greece

U. S. Consul at Athens. The Clay-Working Industries of Greece. *Jour. Soc. Arts*, **50**, 848–9 (1902). (Extract in *Sci. Am. Supp.*, **56** [1424], 22,823 (1903).)

Damour, A.—Note sur une hydrate d'Alumine Ferrugineuse Trouvée dans l'Île d'Egine, Grèce. *Bull. Soc. Géol. France*, **22**, 2nd Ser., 413–6 (1864–65).

McGinley.—Clay Working Industries of Greece. *U. S. Consular Reports*, **69**, 273–6 (1902).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI* (*cont.*), **6**, 385–6 (1901).

Hungary

Horváth, B.—Report from the Chemical Laboratory of the Royal Hungarian Geological Survey. *Magyar Kir. Foldtani Intezet Jelentese*, pp. 471–86 (1915); 511–30 (1916); (*Mineralog. Abstracts* **I**, 385).

Kalecsinszky, A.—A Magyar Korona Országainak Megvizsgált Agyagai. (Clays of Hungary.) *Publicationen der kgl. ungar. Geolog.*, Anst., 1–218 (1905). (Abs., *Geol. Centralb.*, **8,** 415 (1906); Abs., *Jour. Iron and Steel Inst.*, **73,** 383 (1907).)

Kalecsinszky, A. V.—Die Untersuchten Ton der Länder der Ungarischen Krone. *Kgl. Ungarische Geologische Anstalt*, 234 pp. (1906).

Lotti, B.—Ostungarische und Italienische Bauxite. *Zeit. f. prak. Geol.*, **16** [12], 501–4 (1908); (Abs., *Geol. Centralb.*, **13,** 455 (1909).)

Matyasovszky, J. v. and Petrik, L.—Detailkatalog der Thon,- Glas,- Cement,- und mineralfarbenindustrie dienenden Rohmaterialien Ungarns. *Kgl. ungar. Landesanst.* (1895).

Matyasovszky, J. v.—Hungarian Fire-Clay. *Trans. North of Eng. Inst. of Min. Engs.*, **34,** 23 (1884–85).

Petrik, L.—Hungarian Rhyolite Kaolins. *Sprech.*, **43,** 245 (1910).

Rozlozsnik, P.—Preliminary Report on the Bauxite Occurrences of Northern Bihar (Királyerdö). *Magyar Kir. Földtani Intézet Jelentèse* (Budapest), pp. 450–4 (1916); *Mineralog. Abs.*, **1,** 385.

Tökes, L.—Délmagyarország Agyagtelepei (Clays of Southern Hungary). *Természettudományi Füzetek*, **29,** 68–72 (1905). (Abs., *Geol. Centralb.*, **8,** 417 (1906).)

Ws.—Ungarische Kaoline und Kaolinartige Thone. *Sprechsaal*, **34** [35], 1217 (1901).

Iceland

Seger, H.—Zusammensetzung von Bauxit aus Iceland. *Dingler's Polytech. Jour.*, **224,** 334 (1880).

Italy

Aichino, G.—Le Bauxite. 84 pp. (1902?). (Reprinted from *Rassegna Mineraria*, **15,** 225–7, 243–4, 259–65, 276–8 (1901).)

Aichino, G.—Bauxite in Italy. *Eng. and Min. Jour.*, **74,** 41 (1902).

Anon.—Bauxite and Alumina in Italy. *Eng. and Min. Jour.*, **76,** 810 (1903).

Anon.—Kaolin. Rivista del Servizio Minerano (1912).

Barelli, V.—Cenni di Statistica Mineralogica degli Stati di, S. M. il Re di Sardegna, 278 (1835).

Bombici, L.—Kaolin in Province of Bologna. Descrizione della Mineralogia Generale della Provincia di Bologna. Part II.

Brongniart, A.—Traité des Arts Céramique, p. 49–50.

D'Achiardi, G.—Kaolin at Jano near Volterra. Sopra Alcuni Minerali dell' Elba.

De Marchi, L.—Un Giacimento di Caolino nell' Agordino. *Estr. d. Atti e Mem. d. R. Acc. di Sc.*, **23** [4], 1–6 (1907). (Abs., *Geol. Centralb.*, **13,** 9 (1909–10).)

Ferro, A. A.—L'origine delle terre Gialle Veronesi. *Atti. Soc. ligustica di Sc. Nat. e Geogr.*, **16** [3], 179–97 (1905). (Abs., *Geol. Centralb.*, **7,** 515 (1905–06).)

Formenti, C.—Analysen von Vermeutlichen Italienischen Bauxiten. (Extr. from *Gazz. Chim. Ital.*, **31,** 455 (1901).) Groth's *Zeits. f. Krystallog. u. Min.*, **37,** 406 (1903).

Formenti, C.—Analysen von Italienischen Bauxiten. (Extr. from *Gazz. Chim. Ital.*, **32,** 453 (1902).) Groth's *Zeits. f. Krystallog. u. Min.*, **40,** 109–10 (1905).

Formenti, C.—Analisi di Supposte Bauxite Italiana. *Gazz. Chim. Ital.*, **31,** 452–5 (1901).

Girasoli, D.—Sull' Argilla Gialla di Ruvo (Bari). *Atti. R. Ist. d'Incoraggia-*

mento, **60** [6], 15–7 (1909). (Abs., *Geol. Centralb.*, **14,** 371 (1910).)

Guili.—Kaolin at Querceto and Ajola. Statistica Mineralogicci della Toscana.

Lotti, B.—Ostungarische und Italienische Bauxite. *Zeit. f. prak. Geol.*, **16** [12], 501–4 (1908). (Abs., *Geol. Centralb.*, **13,** 455 (1909).)

Martelli, G.—I Giacimenti Bauxitici di Civita d'Antino e Balsorano (Abruzzo). *Rass. Min.*, **29** [4, 5], 49–52, 68–9 (1908). (Abs., *Geol. Centralb.*, **13,** 9 (1909–10).)

Matteucci, R. V.—Kaolin at Torniella. *Boll. dello Soc. Geol. Italiana*, **10,** 664 (1891).

Novarese, V.—Der Bauxit in Italien. *Zeit. f. prakt. Geol.*, pp. 200–301 (1903).

Panichi.—Kaolin in Province of Grosseto. *Rend. R. Accad. Lincei*, **19,** 656 (1910).

Parlati, L.—Studio Analitico di Alcune Materie Prime Ceramiche. *Atti R. Ist. Incoragg.*, **61** [6], 463–77 (1910). (Abs., *Geol. Centralb.*, **16,** 84 (1911).)

Parlati, L.—Sulla Possibile Applicazione Industriale di Alcune Argille de Montescaglioso (Potenza). *Atti R. Istit. di Incoraggiamento*, **62,** 289–96 (1911). (Abs., *Geol. Centralb.*, **16,** 554 (1911).)

Parlati, L.—Studio Analitico di Alcune Argille di Caltanisetta. *Atti R. Ist. di Incoraggiamento*, **63** [6], 159–69 (1912). (Abs., *Geol. Centralb.*, **18,** 250 (1912–13).)

Parlati, L.—Sulla Possibile Applicazione Industriale di Alcune Argille di Montescaglioso (Potenza). *Atti R. Istit. di Incoraggiamento*, **62,** 289–96 (1911). (Abs., *Geol. Centralb.*, **20,** 648 (1913–14).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, pp. 386–8 (1901).

Ristori, G.—Le Terre Refrattarie e da Ceramica fra Altopascio e Monte Carlo (prov. di Lucca). *Giornale di Geol. pratica*, **2** [1–2], 43–9 (1904). (Abs., *Geol. Centralb.*, **8,** 332 (1906).)

Salle, E.—Il Caolino dei Dintorni della Spezia. *Pr. verb. Soc. tosc.*, **12,** 103–6 (1900). (Abs., *Geol. Centralb.*, **2,** 233 (1902).)

Tacconi, E.—Sul Deposito Argilloso di Tartavalle in Valsassina. *Rend. R. Inst. Lombardo di Sc. e Lett.*, **45** [2], 4 (1912). (Abs., *Geol. Centralb.*, **19,** 197 (1913).)

Ugolini, R.—La terra Refrattaria di Lugnano in Provincia di Pisa. *Proc. Verb. Soc. Tosc. Sc. Nat.*, **21,** 5–15 (1912). (Abs., *Geol. Centralb.*, **18,** 249 (1912–13).)

Zezi, P.—I Caolini e le Argille Refrattarie in Italia. *Boll. Com. Geol. d'Italia*, **6,** 299 (1875).

Luxemburg

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 388 (1901).

Monaco

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 389 (1901).

Norway

Dietrichson, B.—Undersökelser over Norske Lerer (Investigations of Norwegian Clays). Part II. Norges Geologiske Undersökelse, *Bull.* **116** (1923).

Dietrichson, B.—Investigations of Nor-

wegian Clays. Norges Geologiske Undersökelse, *Bull.* **120,** 1–52 (1924).

v. Krogh, J.—Undersökelser over Norske Lerer (Investigations of Norwegian Clays). Pt. III. Norges Geologiske Undersökelse, *Bull.* **119** (1923). Pt. I. *Ibid.*, **115** (1923).

Reusch, H.—En Forekomst af Kaolin og Ildfast ler ved Dydland naer Flekkefjord. *Norges Geol. Undersög.*, **32,** Aarbog for 1900, 99–103, Engl. Resumé, p. 235. (Abs., *Geol. Centralb.*, II, p. 517 (1902).)

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, pp. 450–1 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 389 (1901).

Vogt, J. H. L.—Problems in the Geology of Ore Deposits. (Kaolin, Ekkersund-Soggendal.)

Poland

Miernik, W.—Glinki z. niektórych Miejscowośći gub. Radomskiej. *Chemik Polski.* (Der Polnische Chemiker, red. v. Br. Miklaszewski), **9,** 268–72 (1909), (Abs., *Geol. Centralb.*, **14,** 126 (1910).)

Rutkowski, J.—Gliny i Wapienie Potudniowej Cześći Powiatu Czestochowskiego. *Chemik Polski.* (Der Polnische Chemiker, red. v. Br. Miklaszewski), **9,** 148–51 (1909). (Abs., *Geol. Centralb.*, **14,** 129 (1910).)

Portugal

Brongniart, A. and Malaguti.—Über den Ursprung und die Zusammensetzung der Kaoline oder Porcellanthone, 1841; *Pogg. Annal,* **60,** 89 (1843); *Jour. prakt. Chemie,* **31,** 129 (1844).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 389 (1901).

Roumania

Anon.—Kaolin Deposits in the Dobrudja. *Jour. Soc. Chem. Ind.*, **41,** 571R (1922)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 389 (1901).

Savul, M.—Kaolin of Sarisor, Falticeni District, Suceava, Roumania. *Bull. soc. Sci. Acad. Roumaine,* **8,** 197 (1923).

Russia

Anon.—Discovery of Kaolin, etc., in Russia. *Pottery Gaz.*, **47,** 1703 (1922).

Aljexjejeff, W.—Über den Thon von Kossoi Brod an der Tschussowaja. (Extr. from *Verh. d. k. russ. min. ges.*, **35** [2], 63 (1897); Groth's *Zeit. f. Krystallog. und Min.*, **31,** 509 (1899).

Bogndanoff, S.—Analyse des Argiles de Kiew. *Bull. Soc. Chimique,* **2,** pp. 40, 72.

Brongniart, A.—Über Porcellanerde, etc. *Bull. Soc. Géol. France,* **10,** 56 (1839); *Compt. rend.*, **7,** 1085; *Jour. prakt. chemie,* **17,** 118 (1839).

Brongniart, A. and Malaguti.—Über den Ursprung und die Zusammensetzung der Kaoline oder Porcellanthone. (2nd Ed., 1841); *Pogg. Annal.*, **60,** 89 (1843); *Jour. prakt. chemie,* **31,** 129 (1844).

Chirvinskii, P. N.—Microscopic and Chemical Investigation of Several Sedimentary Rocks of the Cretaceous and Tertiary Formations near Wolsk, Govt. Saratow. *Bull. Inst. Poly-*

techn., **4** [2], 122–40 (1915); *Mineralog. Abstr.*, **2**, 73–4.

Fersman, A. E.—Russian Deposits of Fullers' Earth and Allied Substances. *Reports on Natural Productive Forces of Russia*, **1** (1916).

Glinka, K.—Über die Mineralogische Zusammensetzung der Pskower Glacialen Thone und über die Verwitterungstypen. *Verhandl. St. Petersb. kais. min. Ges.*, **2** [37], 333. (Abs., *Geol. Centralbl.*, p. 98 (1901).)

Lawroff, A.—Die Fahrt nach Kissatib, Kreis Achalzich. Mess. d. l'Art. minièr, et d. l'Irrigation au Caucase, No. **21** (1902). (Abs., *Geol. Centralb.*, **4**, 204 (1904).)

Licharew, B.—Die Feuerfesten Tone der Region Tschassowo-Jarsk, Gouv. Jekaterinoslav. *Russische Geologische Comité*, No. **31**, 25 pp. (1918). (Abs., *Geol. Centralb.*, **28**, 160 (1922–23).)

Meffert, B.—Die Tone der Wasserscheide Kama-Wiatka. *Russiche Geologische Comité*, 28 pp., No. **37** (1918). (Abs., *Geol. Centralb.*, **28**, 160 (1922–23).)

Prigarovskii, M. M.—Refractory Clays of Central Russia. Russ. Acad. Sci., *Matter on Natural Resources of Russia*, **35**, 1–59 (1922). (Abs., *Rev. Geol.*, **5**, 98–9.) (Abs., *Geol. Centralbl.*, **19**, 520 (1923).)

Ries, H.—Kaolins and Fire Clays of Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, 451–5 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 390 (1901).

Samoilov, J. V.—Labrador und Kaolin aus Bezirk Elisavetgrad, Gov. Cherson. *Bull. Soc. Imp. Nat. Moscow.*, p. 520 (1903); New Series, **16**, 520 (1903).

Schindelmeiser, J.—Analyse einer Kaukasischen Erdart. *Ber. d. deutschen Pharmaz. Ges.*, **13** [7] (1903). (Abs., *Geol. Centralb.*, **4**, 437 (1904).)

Semjatschenski, P. A.—Die Absorptionseigenschaften der Russischen Tone. *Russ. Akademie der Wissenschaften, Kom. zur Erforschung der Bodenschätze Russlands*, No. **27**, Pts. 1 and 2, 1–67 (1921). (Abs., *Geol. Centralb.*, **19**, 520 (1923).)

Silberminz, W. A.—Die Tonlagerstätten im Kreis Wytegra, Gouv. Olonezk. *Russische Geologishe Comité*, No. **55**, pp. 1–66 (1921). (Abs., *Geol. Centralb.*, **28**, 160 (1922–23).)

Sjögren, H.—Preliminära meddelanden från de Kaukasiska Naftafälten. *Geol. fören Förhandl.*, **13**, 89.

Stopnevich, A. D., Iskul, V. I. and Ovsianikov, B. P.—The Bauxite of Tikhvin from the Geological Chemico-Mineralogical and Technical Points of View. Accad. Sci. Russia, *Matter on the Natural Resources of Russia*, **31**, 1–74 (1919). (Abs., *Rev. Geol.*, **5**, 82–3.)

Walter, H.—Das Kaolinvorkommen von Palanka Gouvernement Podolien. *Zeits. f. prakt. Geol.*, 392–3 (1898).

Warsonofiewa, W. und E. Soschkina.—*Bericht über Untersuchungen der feuerfesten Tone des Gouv. Perm. Erzbote*, **2** [2], 72–81 (1917), [3], 131–46. (Abs., *Geol. Centralb.*, **28**, 232 (1922–23).)

Zemjatschensky, C.—Kaolin and Clays from Kiew, Russia. *Bericht und Forschungen zur Keramischen Industrie in Russland*, **6**, 308–28.

Zemjatschenski, P.—Kaolin in Ekaterinoslav Province. *Trav. d. l. Soc. d. Natural*, p. 1 (1896).

Sardinia

Repossi, E.—The Kaolin Deposit of Furtei in Sardinia. *Rass. min. met. chim.*, **61**, 1 (1924). (Abs., *Chem. Age*, **11**, 15 (1924).)

Servia

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Serv., *21st Ann. Rept., Pt. VI (cont.)*, p. 390 (1901).

Spain

Calderôn, D. S.—Los Minerales de España, **2,** 410 (1910).

Calderôn and Tenne.—Die Mineralfundstätten der Iberischen Halbinsel (1902).

Lindley, W.—Recent Visit to Some Spanish and Portuguese Potteries. *Trans Eng. Ceram. Soc.*, **20,** 72–82 (1921).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 390 (1901).

Sweden

Anon.—Swedish Kaolin. *British Clayworker*, **12,** 6 (1903–04).

Anon.—Statens Järnvägars Geotekniska Kommission Slutbetänkande, 1922. (The Final Memorial of the Geotechnical Commission of the State Railroads.) *Geotekniska Neddelanden*, **2** (1922).

Atterberg, A.—Mekaniska Jordanalysen och Klassifikationen af de Svenska Mineraljordslagen. (The Mechanical Analyses of Earth and the Classification of the Swedish Mineral Strata.) *Kungl. Lantbruks.-Akademiens Handlingar och Tidskrift*, 1912.

Beckman, J. W.—Ceramics as a By-Product of Coal Mining in Sweden. *Chem. Met. Eng.*, **25,** 882.

De Geer, G.—Om Kaolin och Andra Vittrings-rester af Urberg Inom Kristianstadsområdets Kritsystem, *Geol. Fören. i Stockholm, Förhandl.*, **7,** Pt. 12 (1885).

Cronquist, A. W.—Kaolin von Hultabo in Schweden. *Geol. Fören. Stockholm*, **5,** 525 (1880).

Eichstädt, F.—Bidrag till Kännedomen om Kaolinlernorna i Skåne. *Geol. Fören. i. Stockholm, Förh.*, **10** [2], 82–112 (1888).

Grönwall, K. A.—Enny profil i Hörs Sandsten. *Geol. Fören. Stockh., Förh.* **20,** 325 (1898).

Holmström, L.—Anteckningar om Stenindustrien i Noraöstra delen af Skåne. *Geol. Fören. Stockh., Förh.*, **21,** 261 (1899).

Lilienberg, N.—Fire Clays and Fire Bricks in Sweden. (Analyses; Machines for Grinding Clays.) *Trans. Amer. Inst. Min. Eng.*, **13,** 320–30 (1884–85).

Lindström, A.—Om Förekomsten af Kaolin och Kol in blandad lera i Norra Skåne. Nit liner Kartenskizze. *Geol. Fören. i Stockholm, Förh.*, **6** [10], 416–25 (1883). (Abs., *Neues Jahrb. Min.*, **2,** 365 (1883).)

Lindström, A.—Om Förekomsten af Kaolin och Kol in blandad lera i Norra Skåne. *Geol. Fören. i Stockholm Förhandl.* **6** [10], 416 (1882–83). (Abs. Neues Jahrb. Min., **2,** 365, 366 (1883).)

Lindström, A.—Kaolin in Sweden. (Abs. in *Trans. North of England Inst. Min. Eng.*, **32,** 53 (1884).)

Lundgren, B.—Über Kaolin von Schonen. Malmöhus läns Hush. Sällskaps Handlingar (1868–69).

Moberg, J. C.—Om Kaolinfyndigheten å Ifö. *Geol. Fören. Stockh., Förh.*, **25,** 259–81 (1903).

Müller, A.—Mittheilungen aus der neueren Geologie Schwedens. *Jour. für prakt. Chemie*, **90,** 385–99. (Thon von Werunland, p. 394.)

Müller, A.—Analysen Schwedischer Thon-und Erdarten. *Jour. für prakt. Chemie*, **90,** 395–9. (Abs., *Neues Jahrbuch für Mineral.*, p. 478 (1864).)

Natharst, A. G.—Elaüterungen zur geologischen Karte Trolleholm. *Sveriges geol. Undersökn.*, Ser. Aa., No. 87, 8 (1885).

Odelstjerna.—Über den Kaolin von Ifö in Schweden. *Oesterr. Zeitschr, f. Berg.-u. Hüttenw.*, 492–4 (1902). (Abs., *Geol. Centralb.*, **3,** 575 (1903).)

Odén, S. and Reuterskiöld, A.—Zur Kenntnis des Ancylustons. *Bull. Geol. Inst. Univ. Upsala*, **16,** 10 (1919).

Ries, H.—Kaolins and Fire Clays of

Europe. U. S. Geol. Surv., *19th Ann. Rept., Pt. VI (cont.)*, **51,** 448–51 (1897–98).

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, pp. 390–1 (1901).

Santesson, B.—Kaolinfyndigheten vid Hultebo i Skinnskattebergs Socken och Örebro län. *Geol. Fören. i Stockholm Förhandl.*, **6,** 325 (1882–83).

Santesson, B.—Kaolin in Sweden. (Abs., *Trans. North of Eng. Inst. Min. Eng.*, **32,** 53 (1884).)

Switzerland

Balmer, Ch.—Der Thon. *Verhandl. d. schweiz. naturf. Ges.*, **84.** *Jahresvers. zu Zofingen, 1901,* **4–6** [8], p. 305 (1902), Protokollnotiz (Jb. v. Baselland). (Abs., *Geol. Centralb.*, **3,** 575 (1903).)

Goppelstroder, F.—Über feuerfesten Thon den Umgebung von Basel. *Jour. für prakt. Chemie,* **101,** 444 (1867).

Graeger.—Analyse einiger Thone von Lengenau im Solothurn (Schweiz). *Dingler's Polytech. Jour.*, **188,** 420–1 (1868).

Letsch, E., Zschokke, B. und Moser, R.—Die schweizerischen Tonlager. *Beitr. z. Geol. der Schweiz, geotechn.* Ser. 4, Part 4. (Abs., *Geol. Centralb.*, **10,** 394 (1907–08).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 391 (1901).

Schmidt, C. and Hinden, F.—Geological and Chemical Investigation of the Clay Deposits at Alsace and at Allschwyl near Basle. *Zeits. prak. Geol.*, **15,** 46–56 (1907). (Abs., *Geol. Centralb.*, **12,** 27 (1909).)

Zschokke, B.—Die Untersuchung der Tonlager des Schweizerischen Ziegler-vereins in der eidgenössischen. *Materialprüfungsanstalt am schweizerischen Polytechnikum.*, **8,** 44 (1902). (Abs., *Geol. Centralb.*, **4,** 74 (1904).)

Turkey

Ries, H.—Clayworking in Turkey. *The Clayworker,* **30,** 9 (1898).

ASIA

Ceylon

Grünling, F.—Über die Mineralvorkommen von Ceylon. *Zeits. f. Krystall.*, **33,** 229 (1900).

China

Anon.—Clays in Manchuria. *The British Clayworker,* **16,** 238 (1907–08).

Anon.—White Earth, Its Competition with China Clay. *British Clayworker,* **29,** 18–9 (1920).

Anon.—The Ceramic Industry in China. *The British Clayworker,* **31,** 232 (1922–23).

Anon.—Chinese Kaolin for American Potteries. *Far Eastern Rev.*, **18,** 511–4 (1922).

Clements, J. M.—Chinese Clays for Export. *Brick,* **61,** 562 (1922).

Clements, J. M.—Kaolin Available in China. *Commerce Reports,* No. **15,** 85 (1922).

Du Halde.—Description de l'empire de la Chine et de la Tartare Chinoise. La Haye, 1736, Tome 2: English translation by R. Brooks. *The General History of China,* **2,** 3rd ed., 308, London (1741). Kaolin.

Du Halde and Julien, S. A.—Kaolin near Ching-tê-Chên. Histoire et fabrication de la Porcelaine Chinoise (1856).

Ebelmen and Salvétat.—Analysis of Kaolin from China. *Annal. chim. phys.*, **31** [3], 257 (1852).

Kalmann, W.—Analysen von Chinesischen Porzellanerden und Glasurmassen. *Ding. Polytech. Jour.*, **220,** 445–6 (1876).

Pabst, W.—Untersuchung von Chinesischen und Japanischen zur Porzellanfabrikation verwendten Gesteinsvorkomminssen. *Zeits. Deutsch. Geol. Gesel.*, **32,** 223 (1880).

Richtofen, F. v.—On the Porcelain Rock of China. *Amer. Jour. Sci.*, 3rd Ser., **1,** 179–81 (1871).

Vogt, G.—De la Composition des Roches Employées dans la Fabrication de la Porcelaine en Chine. *Compt. rend.*, **110,** 43 (1890).

Whitfield, E.—Analyses of Two Porcelain Clays from China. U. S. Geol. Surv., *Bull.* **27,** 71–2 (1886).

India

Boudouard, O. and Lefranc, J.—Clays. III. Clays of Hamman-Meskoutine. *Bull. Soc. Chim.*, **33,** 581–7 (1923).

Conrad, R.—Clay Industry of Southern India. *Tonind. Zeit.*, Sept. 2, 1339 and Sept. 4, 1347 (1913).

Dunstan, W. R.—Report on Laterite from the Central Provinces of India. *Rec. Geol. Surv. Ind.*, **32,** 213–20 (1903–04).

Fermor, L. L.—Clay in India. *Geol. Surv. of India., Records,* **53,** 256 (1922).

Fox, C.—The Bauxite Resources of India. *Min. Mag.*, **26,** 82–96 (1922).

Granger, A. A. and Brémond, P.—Note on the So-called Kaolin of Djebel-Debar. *Trans. Eng. Ceram. Soc.*, **22,** 283 (1923).

Gyengar, P. S.—Notes on Some Kaolin and Clay Occurrences in the Koppa Taluk. *Records, Dept. Mines and Geology, Mysorse State,* **15,** 118 (1916).

Knight-Hallowes, K. A.—The China Clay of Karalgi, Khanapur, Belgaum District. *Rec. Geol. Surv. Ind.*, **55,** 260–7(1923).

Lang, R.—Geological-Mineralogical Observations in India. II. Recent Brown Earth and Humus Formation. *Centr. Min. Geol.*, pp. 513–8, 545–51 (1914); *Ibid*, pp. 257–61.

Ras, B. B.—Notes on Prospecting for Kaolin in the Koppa Taluk. *Records, Dept. Mines and Geology, Mysore State,* **15,** 138 (1916).

Stuart, M.—China Clay and Fire Clay Deposits in the Rajmatah Hills. *Rec. Geol. Surv. India,* **38,** Pt. 2, 133–48 (1909).

Warth, H. and Warth, F. J.—The Composition of Indian Laterite. *Geol. Mag.*, **10,** 154 (1903).

Japan

Abbott, J. F.—Pottery Making in Japan. *Clayworker,* 596–7, 646 (1920).

Anon.—Fire Clay in the Vicinity of Taira, in the Prefecture of Tukushima. Imp. Geol. Surv. Japan. *Ind. Min. Surv. Rept.*, **3,** 47–82 (1921). (Abs., *Geol. Centralb.*, **28,** 457 (1922–23).)

Anon.—Refractory Materials Produced at the Kanakura Mine. *Jour. Jap. Cer. Assoc.*, **32,** 251 (1924).

Hojo, K.—Porcelain Clay at Shinobu-Yama in the Prefecture of Fukushima. Imp. Geol. Surv. Japan., *Ind. Min. Surv. Rept.*, **1** [1–11] (1921).

Hojo, K.—Porcelain Clay at Nakanokawa-Mura, Onuma-Gori. Imp. Geol. Surv., Japan, *Ind. Mineral. Surv. Rept.*, **1** [1–11], 81–9 (1921).

Hojo, K.—Porcelain Clay at Okinashima-Mura, Yama-gori, Prefecture Fukushima. Imp. Geol. Surv. Japan,

Ind. Mineral. Survey Rept., **1** [1–11], 91–102 (1921).

Hojo, K.—Porcelain Clay at Oki-Mura, Onuma-Gori. Imp. Geol. Surv., Japan, *Ind. Mineral Surv. Rept.*, **1** [1–11], 61–79 (1921).

Hojo, K.—Porcelain Clay at Naganuma, Iwase-Gori, Prefecture Fukushima. Imp. Geol. Surv., Japan, *Ind. Mineral Surv. Rept.*, **3**, 31–46 (1921).

Hojo, K.—Porcelain Clay at Hongo-Yama, Onuma-Gori, Prefecture Fukushima. Imp. Geol. Surv. Japan, *Ind. Mineral Surv. Rept.*, **1** [1–11], 37–60 (1921).

Hojo, K.—Fire Clay in the Vicinity of Taira, in the Prefecture of Fukushima. Imp. Geol. Survey of Japan, *Ind. Mineral Survey Rept.*, **3**, 47–82 (1921); *Japan J. Geol. Geog.*, **1**, 13A.

Hojo, K.—Clay, Quartzite, Pumiceous Sand and Fluorite in the Prefecture of Miye. Imp. Geol. Surv. Japan, *Ind. Mineral Surv. Rept.*, 10 (1922); *Japan T. Geol. Geog.*, **2**, 10A.

Hojo, K.—Clays of Mount Hongo in Fukushima Prefecture. *Jour. Japan. Ceram. Assoc.*, **355**, 98–105 (1922).

Ihara, K.—Clay at Nankwan in the Prefecture of Kumamoto. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **7**, 41–9 (1922); *Japan J. Geol. Geog.*, **1**, 24–5A.

Ihara, K.—Clays and Steatite, Gotō Island, Nagasaki-Ken (Western Japan). Imp. Geol. Surv. of Jap., *Ind. Min. Surv. Rept.*, **4** (1921).

Ihara, K.—Porcelain Clay Deposits in Saga Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **5**, 1–48 (1921). (Abs., *Geol. Centralb.*, **19**, 390 (1923).)

Ihara, K.—Clays of Sagaken (Western Jap.). Imp. Geol. Survey of Jap., *Ind. Min. Surv. Rept.*, **5** (1921).

Ihara, K.—Ceramic Materials in the Saga Prefecture. *Jour. Jap. Ceram. Soc.*, **3**, 353 (1922).

Julien, S. A.—Mémoire sur les Principales Fabriques de Porcelaine au Japan. *Histoire et Fabrication de la Porcelaine Chinoise*, 275 (1856).

Kimura, R.—Clay and Quartz Sand of Soma and Futaba Counties, in the Prefecture of Fukushima. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **9** (1922); *Japan Jour. Geol. Geog.*, **2**, 13–4A.

Koyama, K., Ishida, T., Nakamura, Y.—Roofing Tile Industry in Ishikawa Prefecture. *Jour. Jap. Ceram. Assoc.*, **369**, 243–54 (1923).

Kujono, N.—Distribution of the Industrial Minerals in Japan. Imp. Jap. Geol. Surv., *Ind. Min. Rept.*, **2** (1921).

Kujono, N.—Clay, Quartz Sand and Feldspar in the Environs of Seto, Aichi Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **11** (1922); *Japan Jour. Geol. Geog.*, **2**, 12–3A.

Kujono, N.—Porcelain Clay and Fire Clay in the Northern Part of Nishikamo County, Aichi Prefecture. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **10** (1922); *Japan Jour. Geol. Geog.*, **2**, 9–10A.

Matsuno, K.—Clay at Imbé, Wake-Gori. Prefecture Okayama. Imp. Geol. Surv. Japan, *Ind. Min. Surv. Rept.*, **2**, 79–85 (1921).

Notomi, S.—Report on the Clay Used for Soma Wares. Jap. Geol. Survey, *Bull.* No. **67.**

Okazawa, T.—Studies on Clays. I. The Acid Reaction of Japanese Acid Clays. *Bull. Insi. Phys. Chem. Research* (Jap.), **2**, 189–221 (1923).

Pabst, W.—Untersuchung von Chinesischen und Japanischen zur Porzellanfabrikation verwendten Gesteinsvorkommnissen. *Zeits. Deutsch. Geol. Ges.*, **32**, 223 (1880).

Shigomune, R.—Comparative Examination of Japanese and Foreign Porcelain. Tokio Ind. Lab. Report, **17** [6], 59 (1922).

Soga, M.—Clays of the Chita Peninsula, Aichiken (Central Japan). Imp. Jap. Geol. Surv., *Ind. Min. Surv. Rept.*, **7** (1921).

Suzuki, T.—On Clay. *Jour. Jap. Cer. Assoc.*, **370**, 310–4 (1923).

Wurtz, H.—The Chemistry and Composition of the Porcelains and Porcelain Rocks of Japan. *U. S. Inter. Exhibition*, **3**, 604–37 (1880); also *Amer. Jour. Sci.*, **13** [35], 389–90 (1877).

Korea

Kitamura, Y.—Investigation of Gairome Clay found in Seikirei, Korea. *Jour. Chem. Ind. Tokyo*, **20**, 833–44 (1917).

Malay States

Anon.—Pottery Clays in the Malay States. *Bull. Imp. Inst.*, **14**, pp. 120–21 (1916).

Anon.—Report on the Occurrence of Various Kinds of Clays Including Supposed Kaolins. *Pottery Gaz.*, **42**, 11, 68 (1917).

Anon.—China Clay in Perak. *The British Clayworker*, **31**, 47 (1922–23).

Anon.—China Clay in Johore. *British Clayworker*, **32**, 95 (1923–24).

Jones, W. R.—Clays of Economic Importance in the Federated Malay States. (Abs. in *Bull. of Imp. Inst.*, **14**, 120–21 (1916).)

Scrivenor, J. B.—The Origin of the Clays and Boulder-Clays, Federated Malay States. *Geol. Mag.*, **5**, 157 (1918).

Scrivenor, J. B.—The Kaolin Veins. *Geol. Mag.*, **5**, 79 (1918).

Mauritius

Anon.—Local Clays for Brick and Tile Manufacture in Mauritius *Bull. Imp. Inst.*, **21**, 587–96 (1923).

Netherland Indies

Mohr, E. C. J.—Materials for Ceramic Industry in Dutch East Indies. *Ber. Afd. Handelsmuseum Kolonial Inst.*, No. 14, 12 pp. (1923).

Mom, C. P.—Vollersaarde. Het Voorkomen in Nederlandsch—Indië en de Eigenschappen, Inzonderheid het Oliekleurend Vermogen. Mededeelingen van het Laboratorium voor Agrogeologie en Grondonderzoek van het Algemeen Proefstation voor den Landbouw, No. 3, 1917. (Abs., *Geol. Centralb.*, **26**, 394 (1921).)

Mom, C. P.—Kaolin en Kwartszand. Grondstoffen voor Vuurvaste Steenen Glasfabricage in Nederlandsch Indië. Mededeelingen van het Laboratorium voor Agrogeologie en Grondonderzoek van het Algemeen Proefstation voor den Landbouw, No. 4, 1918. (Abs., *Geol. Centralb.*, **26**, 395 (1921).)

Ries, H.—Clays and Clay Products at the Paris Exposition of 1900. U. S. Geol. Surv., *21st Ann. Rept., Pt. VI (cont.)*, p. 386 (1901).

Van Amstel, G. E.—Chemical Investigations of some Clay Soils of Surinam. *Dept. Land. Surv., Bull.* **41**, p. 1921.

Seychelle Islands

Bauer, M.—Beiträge zus Geologie der Seychellen. *Neues Jahrb. f. Min.*, **2**, 163 (1898).

AUSTRALIA

General

Anon.—Australian Pottery Clay. *Bull. Imper. Inst.*, **19**, 465–8 (1921).

Anon.—Australian Pottery Clay. *Bull. Imp. Inst.*, **19**, 765 (1921).

Callister, R. C.—Australian Clays in the Manufacture of White Pottery Wares. *Australian Inst. Sci. and Indus., Bull.* **27** (1924).

Knibbs, G. H.—*Official Yearbook of Commonwealth of Australia, 1901–1919*, **13**, 481 (1920).

McMeekan, J.—Notes on Fire Bricks, Fire Clays and Other Refractory Materials. *Trans. of Inst. of Eng., Australia*, **1**, 380–7 (1921). (Abs., *Jour. Iron and Steel Inst.*, **107** [1], 611 (1923).)

New South Wales

Anon.—Analyses of Clays. Dept. Mines, N. S. W., *Ann. Rept.*, p. 53 (1890).

Anon.—Analyses of Clays. Dept. Mines and Agricult.; N. S. W. *Ann. Repts.: 1891*, pp. 59–61; *1892*, pp. 56, 57, 58, 60; *1893*, pp. 51–3; *1894*, pp. 61, 62, 65; *1895*, pp. 70, 73; *1898*, p. 79; *1899*, p. 204.

Anon.—Analyses of Clays. Dept. Mines, N. S. W. *Ann. Repts.: 1900*, p. 205; *1902*, p. 130; *1903*, p. 142; *1904*, p. 152; *1906*, p. 179; *1907*, p. 177; *1910*, p. 185; *1911*, p. 201; *1912*, p. 195; *1913*, p. 188; *1914*, p. 216; *1915*, pp. 194–7; *1916*, pp. 222–3; *1917*, pp. 177–8; *1919*, pp. 183–5; *1920*, p. 122.

Anon.—Report on Clays at Boxer's Creek. Dept. Mines and Agric., N. S. W., *Ann. Rept., 1899*, p. 189.

Anon.—Report on Clay at Ulladulla. Dept. Mines, N. S. W., *Ann. Rept., 1906*, p. 170.

Anon.—Pipe Clay, Pottery Clay, Kaolin, etc., in New South Wales. Dept. of Mines, N. S. W., *Ann. Rept., 1919*.

Cambage, R. H.—Clays. *Chem. Eng. Min. Rev.*, **15**, 317 (1923).

Card, G. W.—On Fullers' Earth from Wingen. *Records of the Geol. Surv., New South Wales*, **4**, Pt. 1, 30–2 (1894).

Carne, J. E.—Local Refractory Materials Used in Manufacture of Fire Brick. *Mineral Resources (N. S. W.)*, No. **6**, pp. 168–84 (1899).

Carne, J. E.—Fire Brick and Pottery Clays. Dept. Mines, N. S. W., *Rept. on Geology and Mineral Resources of Western Coalfield, 1908*, pp. 237–40.

David, T. W. E.—Origin of the Laterite in the New England District of New South Wales. *Proc. Australasian Assoc. Adv. Sci.*, **1**, 233–91 (1899).

Dun, W. S.—Contributions to a List of Papers and Reports Dealing with the Economic Geology of New South Wales. (Bibliography of Clays.) *Records Geol. Surv. of New South Wales*, **6**, Pt. 4, 354–7 (1900).

Harper, L. F.—Report on White Clays near Blayney. Dept. Mines, N. S. W., *Ann. Rept., 1905*, p. 152.

Jaquet, J. B.—Report upon Clay Deposits at Boxer's Creek, near Goulburn. Dept. Mines, N. S. Wales, *Ann. Rept., 1899*.

Liversidge, A.—Clays. *Min. Resources N. S. Wales*, 193–5 (1888).

Mingaye, J. C. H.—Clays from New South Wales. Dept. Mines, New South Wales, *Ann. Rept., 1891*, p. 277–9 (1892).

Morrison, M.—Report on Pottery Clays. Dept. Mines, N. S. W., *Ann. Rept., 1918*, p. 160.

Pittman, E. F.—The Discovery of Bauxite. Dept. Mines, N. S. Wales, *Ann. Rept., 1899* (1900).

Pittman, E. F.—Clays of New South Wales. *Min. Resources New South Wales*, pp. 432–6.

Plummer, John.—Bauxite in New South Wales. *Eng. and Min. Jour.*, **73**, 763 (1902).

Raggatt, H. G.—Fullers' Earth. N. S. W. also Dept. Mines, *Geol. Surv., Bull.* **14**, 15 (1924).

Smith, H. G.—On Kaolinite from Hawkesbury Sandstone. *Jour. Proc. Royal Soc. New South Wales, 1891*, **25**, 171–8 (1891).

New Zealand

Anon.—China Clay in New Zealand. *Jour. Ind. and Eng. Chem.*, Sept., 1915.

Director of Sci. and Tech. Dept. of the Imp. Inst. London.—Report on Clay from the Harokiwi Valley. *New Zealand Mines Record*, **5**, 383 (1901–02).

Binns, G. J.—Clays and Sands (in N. Zealand). *Trans. Federated Inst. Min. Eng.*, **4**, 77 (1893).

Howe, J. A.—A Handbook to the Collection of Kaolin, China Clay and China Stone. *Handbook Mus. Proc. Geol.*, p. 108 (1914).

Jameson, A. B.—The Technical Analyses of Auckland Clays. *New Zealand Jour. Sci. Tech.*, **2**, 209–19 (1919).

Morgan, P. G.—Clay and Fullers' Earth. *New Zealand Jour. Sci. Tech.*, **2**, 119 (1919).

Rowe, H. V.—A Systematic Examination of the Refractory Clays of the Canterbury District, with Special Reference to their Use for Fire Bricks and Furnace Linings. *New Zealand Jour. Sci. Tech.*, **1**, 4 (1918).

Queensland

Anon.—Queensland China Clay. *The British Clayworker*, **15**, 209 (1906–07).

Anon.—Clays. *Board of Trade Jour.*, **65**, 343. (Abs. in *Jour. Iron and Steel Inst.*, **80** [2], 348 (1909).)

South Australia

Anon.—Clay in South Australia. *British Clayworker*, **12**, 361 (1903–04).

Anon.—*A Review of Mining Operation in South Australia, No. 9, 1908.* P. 48 (1909) and *op. cit. No. 13, 1910*, p. 23 (1911).

Jack, R. L.—Fire Clay in South Australia. *Rev. Min. Oper., South Australia*, **26**, 1917. (Abs. in *Imp. Inst. Bull.*, **16**, 119 (1918).)

Ward, L. K.—Report on the Clays Worked by the Longwood Tessellated Tile Co., Ltd., at Longwood. S. Australia Dept. of Mines. *Mining Review*, **32**, 38–40 (1920).

1——Scattered Notes Including Analysis in Annual Report of Director of Mines and Government Geologist for 1916, pp. 9, 11–8. Also in the *South Australia Mining Review* as follows: No. 20, p. 34; No. 24, pp. 51–2; No. 26, pp. 38–41; No. 32, pp. 38–40; No. 33, pp. 46–7; No. 39, pp. 54–8.

Tasmania

Twelvetrees, W. H.—Report on Clay Deposits at St. Georges Bay, Tasmania. Government Printer, 10 pp.

Victoria

Anon.—Kaolin near Lintons in Argyle. Secretary for Mines, Melbourne, Victoria. *Annual Report.*

Anon.—Clay Deposits of Victoria. *The British Clayworker*, **15**, 181 (1906–07).

Anon.—Australian Pottery Clay. Pottery Clay from Bendigo Victoria. *Bull. of Imp. Inst.*, **21**, 321–4 (1923).

Callister, R. C.—Porcelain Clays of Ballarat. *Chem. Eng. Mining Rev.*, **15**, 36–43 (1922).

West Australia

Campbell, W. D.—Clay Deposits of the Clackline District. Geol. Surv. W. Austral., *Ann. Rept. Prog., 1906*, pp. 24–5 (1907).

Feldtmann, F. R.—Clay Deposits at Three Springs. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, pp. 32–3 (1919).

Feldtmann, F. R.—Clay Deposits at Mount Kokeby, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, p. 33–5 (1919).

Feldtmann, F. R.—The Clay Deposits of Bolgart, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, pp. 27–9 (1920).

Feldtmann, F. R.—The Clackline and Baker's Hill Clay Deposits, Southwest Division. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, p. 29–30 (1920).

Homan, C. S.—The Extension of the Kelmscott Clay Deposit. Geol. Surv., W. Austral., *Bull.* **48**, p. 63–5.

Larcombe, C. O. G.—The Geology of Kalgoorlie. *Trans., Australasian Institute of Mining Eng.*, **14**, 182, 257 (1912).

Simpson, E. S.—Fire Clay at West Collie (Moira) Colliery, Collie Coalfield. Geol. Surv., W. Austral., *Bull.* **6**, p. 58 (1902).

Simpson, E. S.—Clays at Newlands. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1906*, p. 28–9 (1907).

Simpson, E. S.—Clays (Tables of Analyses). Geol. Surv., W. Austral., *Bull.* **67**, 104–7, 116, 117 (1916).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1918*, p. 35 (1919).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1919*, p. 35 (1920).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1920*, p. 21 (1921).

Simpson, E. S.—Clays. Geol. Surv., W. Austral., *Ann. Rept. Prog., 1921*, p. 52 (1922).

Simpson, E. S.—The Mineral Resources of Western Australia. *Folder No. 2*, pp. 13–5 (1924). (Compiled for British Empire Exhibition.)

Woolnough, W. G.—The Physiographic Significance of Laterites in Western Australia. *Geol. Mag.*, **5**, 385–93 (1918).

AFRICA

Algeria

Granger, A. and Brémond, P.—The Chemical Composition of Rock Known as the Kaolin from Djebel-Debar (Algeria). *Comptes Rendus*, **175**, 36–8 (1922).

Parran, A.—Sur les Terrains de Gneiss des Environs de Bône. (Kaolin.) *Bull. Soc. Géol. France*, p. 509 (1883).

British Somaliland

Anon.—Clay from British Somaliland. *Bull. Imp. Inst.*, **22** [1], 66 (1924).

East Africa

Anon.—The Manufacture of Tiles in East Africa. *Bull. Imperial Inst.*, **19** [3], 297–311 (1921).

Egypt

Banks, E. J.—Clay Products of Babylonia. *The Clayworker*, **47**, 58–60 (1907).

Guinea

La Croix, A.—Les Laterites de la Guinée et les Produits d'Alteration qui leur sont Associatés. *Nouv. Arch. du Musée*, **5** [5], 255–356 (1914).

German East Africa

Anon.—Kaolin. Economic Resources of the German Colonies. *Bull. Imp. Inst.*, **12** [4], 598 (1914).

Gold Coast

Kitson.—Mineral Resources of Gold Coast. *Min. Mag.*, 1925.

Madagascar

Bauer, M.—Beitrag zur Kenntnis des Laterits, insbesondere dessen von Madagascar. *Neues, Jahrb. für Min. Geol. u. Pal., Festband*, 33–90 (1907).

Lacroix, A.—Sur la Kaolinite Cristallesèe de Nossi-Bé. *Bull. Soc. franc. Min.*, **24**, 34–5 (1901).

La Croix, A.—Les Produits des Roches Silicates et Alumineuses, et en Particulier les Laterites de Madagascar. *Compt. rend.*, **159**, 617 (1914).

Mozambique

Holmes, A.—The Lateritic Deposits of Mozambique. *Geol. Mag.*, **1** [6], 529–36 (1914).

Natal

Anon.—Kaolin Deposits in Natal. *The British Clayworker*, **17**, 219 (1908–09).

Nigeria

Anon.—China Clay Analyses. *Tonind. Zeit.*, **25** [46], 672 (1901).

Anon.—Tile and Brick-Making materials of Nigeria. *Bull. Imp. Inst.*, **21**, 302–10 (1923).

Rhodesia

Anon.—Mineral Resources of Rhodesia. Bulawayo 1910, *9th Annual Report Rhodesian Museum*, pp. 35–60.

Mennel, F. P.—Notes on Rhodesian Laterite. *Geol. Mag.*, **6**, 350–2 (1909).

Sierra Leone

Dixey, F.—Notes on Laterization in Sierra Leone. *Geol. Mag.*, **57**, 211 (1920).

South Africa

Adams, J.—Clays of South Africa. *The British Clayworker*, **27**, 122 (1918–19).

Adams, J.—The Manufacture of Ceramic Wares in the Union. *Pretoria South Africa Jour. of Industries*, p. 763 (1918).

Anon.—China Clay in Capetown. *British Clayworker*, **8**, 71 (1904–05).

Anon.—Raw Materials for the Ceramic Industry in South Africa. *Bull. Imp. Inst.*, **18**, 271–9 (1920).

Anon.—Brick Making in South Africa. *British Clayworker*, **31**, 91 (1922).

Rogers, A. W.—Occurrence of Diaspore in the Transvaal on Mooikopje, 58, Middleburg. *Trans. Geol. Soc. S. Afr.*, **27**, 71–5 (1924). Analyses of kaolinite and diaspore.

Wagner, P. A.—Fire Clay in Olinfantsfontein. *Trans. Geol. Soc. S. Africa*, **19**, 36 (1916). (Abs. in *Bull. Imp. Inst.* p. 288 (1917).)

Uganda

Anon.—Pottery Clays from Uganda. *Bull. Imp. Inst.*, **22** [3], pp. 296–303 (1924).

PACIFIC OCEAN ISLANDS

Hawaiian Islands

Clarke, F. W. and Hillebrand, W. F.—Analyses of Rocks and Analytical Methods. U. S. Geol. Surv., *Bull.* **148**, p. 301 (1897).

New Caledonia

Davis, W. M.—Metalliferous Laterites in New Caledonia. *Proc. Nat. Acad. Sci.*, **4**, 275–80 (1918).

Philippine Islands

Cox, A. J.—The Occurrence, Composition and Radioactivity of the Clays from Luzon, Philippine Islands. *Phil. Jour. Sci.*, **2A** [6], 413. (Abs., *Geol. Centralb.*, **11**, 215 (1908).)

Cox, A. J.—Laguna Clays. *Philippine Jour. Sci.*, **3** [5] (Sec. A., General Science), Nov. (1908).

Growe, C. H.—Philippine Clay Work. *The Mineral Resources of the Philippine Islands for the Year 1911*, p. 97. (Abs., *Geol. Centralb.*, **21**, 199 (1914–15).)

ACTIVITIES OF THE SOCIETY

THE FALL MEETING

Grand Central Palace, Thursday, October 1

Ceramic Day at Chemical Exposition

The general theme—shall ceramic products, their properties, specifications and service requirements be stressed more in collegiate ceramic courses.

A lively and worthwhile list of speakers are preparing papers, E. Ward Tillotson, Frank H. Riddle, Alexander Silverman, Charles W. Hill, Amos P. Potts, Frederick H. Rhead, Hewitt Wilson, W. K. McAfee and R. D. Landrum. Other speakers are assured but definite assignments and acceptances have not been registered at the time of going to press (Aug. 18).

A joint dinner has been planned for the evening of October 1 at Hotel Commodore with the several chemical societies. Eminent industrialists will be speakers. Detailed announcements will be issued by card.

NEW MEMBERS RECEIVED FROM JULY 15 TO AUGUST 15

PERSONAL

Holland R. Bacher, Rock Tavern, N. Y. President, White Cloud Farms, Inc.

Mathew M. Braidech, Jr., Y. M. C. A., Pittsfield, Mass. Chemical Engineer, General Electric Co.

J. B. Fauchon, Paray-le-Monial (S. & L.), France.

Frank G. Gibson, Malvern, Ohio.

A. C. Harrison, 1791 Lanier Place, Apt. 42, Washington, D. C. Junior Scientist, Bureau of Standards.

Gustav Hoppe, Belgrad, Terarije 14, Jugoslavia.

Gordon C. Keith, Secretary, Canadian National Clayworkers Association, 51 Wellington St., Toronto, Ont., Canada (Honorary Member).

Charles E. Miller, Darlington Brick & Mining Co., Darlington, Beaver Co., Pa.

David W. Miller, Ironton Fire Brick Co., Ironton, Ohio. Ceramist.

Lemon Parker, Parker-Russell Mfg. Co., St. Louis, Mo.

Colin Presswood, General Refractories Co., Ltd., 28 Blonk St., Sheffield, England.

Hugo Wilisch, Konigswinter, Rhine, Germany.

CORPORATION

Central of Georgia Railway Co., Savannah, Ga. J. M. Mallory, General Industrial Agt.

Membership Workers' Record

	Personal	Corporation
C. E. Bales	1	
G. A. Bole	1	
C. F. Geiger		1
R. F. Geller	1	
F. G. Jackson	1	
George Simcoe	1	
F. C. Woodside	1	
Office	6	
	12	1

MISS SHEERER RETURNS FROM PARIS

Miss Mary G. Sheerer, Chairman of the Art Division, has returned from Paris where she attended the International Exposition of Modern Decorative and Industrial Arts. Miss Sheerer was appointed as a delegate by Herbert Hoover, Secretary of Commerce of the United States. A report of this Exposition follows below.

PERSONAL NOTES OF MEMBERS

A. I. Andrews, who has for the past year been Professor of Ceramic Engineering at Alfred University, has accepted a position at the University of Illinois as Assistant Professor of Ceramic Engineering. Previous to his association with Alfred University Dr. Andrews was employed at the Ceramic Station of the U. S. Bureau of Mines, his chief investigation being on dolomite refractories.

Dr. Andrews received his B.S. and M.S. in chemistry at the University of Wisconsin and Ph.D. at Ohio State University in 1924.

VISIT OF THE DELEGATION OF AMERICAN LUXURY INDUSTRIES TO THE INTERNATIONAL EXPOSITION OF MODERN DECORATIVE AND INDUSTRIAL ARTS, PARIS 1925

By Mary G. Sheerer

As a member of this delegation it is my pleasure to send an account of this important visit to Paris to the Art Division of the American Ceramic Society.

A Commission of four men, with Charles R. Richards as Director, was appointed by Herbert Hoover, United States Secretary of Commerce, to visit and report on the Exposition.

The Commission sent out notices to this effect urging the industries and craft societies to send delegates to assist with the report. There were about 125 delegates, including interior decorators, furniture and other household manufacturers, textile, wrought iron, stained glass designers and makers, architects and representatives from arts and crafts societies.

Wishing, as Chairman of the Art Division, to get more in touch with the industries and feeling sure that Paris and its Exposition had a message for us in America, I went over to attend the meetings of the Commission and to visit the Exposition with them.

Mrs. Adelaide Robineau was another representative of the pottery craft and Mr. Holmes of the Lenox Belleek was one of the four Commissioners.

The objective of the Commission may best be given by quoting from the program arranged by the French and American committees.

As presented by L. P. Sézille, a leading architect of Paris and the Exposition and a member of the French Committee of Entertainment, the object was:

"1. To acquaint the delegates of the United States of America with the extent of the French effort as applied to all branches of modern decorative art.

"2. To arouse interest on the part of the delegates in our modern creations with a view to achieving practical commercial results between the United States and France.

"To attain this end a program should be drawn up embodying a dual selection: first, a selection of aesthetic order, grouping purely beautiful works; second, a selection conforming with American psychology.

"As a matter of fact due account should be taken of:

"1. The infatuation of Americans for classical works established by tradition.

"2. The normal reaction of connoisseurs of exclusively antique art who will mercilessly draw attention to the defects of certain modern works.

"3. The visitors' difficulty in adapting themselves to certain formulas with which the French are already familiar, whereas we are not.

"The initial effort should, therefore, be directed toward convincing the American delegates of the fact that, side by side, with works whose commonplace or eccentric character has been purposely exaggerated, there exist productions which are so well balanced that they may rank with time-honored works of antique style which, on their part, form the selection made by taste and time from efforts comparable to those of our epoch.

"(It would have been desirable in this connection to have found it possible to introduce the delegation into the homes of some famous collectors who, side by side with catalogued works of art, have made place for a few fine examples of the work of modern decorators; but the time allowed does not appear sufficient to enable this plan to be considered.)

"In the limited time (13 visits of an average of two hours) which the delegation can devote to this study, 'courses and lectures' cannot be contemplated. The works themselves, without any preparations, must win the cause.

"For this very reason the program must confine itself to such modern products as are sufficiently near classical forms to be understood and accepted.

"Later on, if we are fortunate enough to win this 'first lap,' a time will come when our American friends may take an interest as we do in all vanguard efforts without our having to fear a failure which at this time would be detrimental to the interests of France."

In detail the general program reads:

1. Visits to the Exposition of decorative art
2. Visits to decorators' plants and showrooms
3. Visits to the schools and manufactories
4. Visits to public institutions and industrial and private buildings

Constituting a cycle which will demonstrate:

1. The development of modern production on the part of artists and manufacturers.
2. The organization of a system of tuition preparing the continuity of the tendency toward modernization.
3. The adaptation of new formulas to the requirements of modern life.

Division of time: five visits to the Exposition; eight visits elsewhere.

Besides this comprehensive program, there were numerous receptions, luncheons, banquets and gala occasions given by the French Government, the Commissioner General of the Exposition, the Baron and Baroness Rothschild and the beautiful fête at Versailles.

The first visit to the Exposition included the ceramics and glassware of the luxury industries, details of which I shall give in another article.

Another visit was to the French Artisan Pavillion, which was largely devoted to the group of artist-craftsmen who lead the way in advancing the taste of the times, and whose work is reflected and made popular by the manufacturers.

The earthenware, stoneware, porcelains and glassware of the French artisans, together with similar work by the Danish, Swedish and English in the Grand Palais, was the pulse of the ceramic household arts to me.

It is among the artisans that we must look for fresh impulse and for an individual

expression of art in one medium or another. When their influence has been sufficiently felt by the schools, it is reflected by the manufacturer and the taste of the public is advanced. Parenthetically, let me say, that I hope the next step on the part of the museums will be to encourage the artisan by special exhibitions of his work as a few museums are now doing for the manufacturers. Both the manufacturer and the artisan reach our home life at every turn and are a powerful factor in making or marring our sense of beauty.

Simplicity of form and decoration characterize the best work at the Exposition, with quality of surface whether stoneware or glazed pieces, a prominent feature.

Some of the newest table ware made to harmonize with the modern furniture is of a cream white, with flowers cut and modeled in the wet clay without any change of color. A set of this kind was very effective on a table and sideboard of Chinese red lacquer and ivory knobs and harmonized with the straight lines of the furniture.

I shall have another detailed article of some of the ceramic household arts at the Exposition.

NOTES AND NEWS

NEW RULING IN A. A. A. S.

On account of the recent affiliation of the American Ceramic Society with the American Association for the Advancement of Science, all members of the Society who are not already members of the Association are now entitled to the special privilege of becoming members of the Association without paying the usual five-dollar entrance fee. This privilege has been extended till January 1, 1926, when it will automatically come to an end. Information about the American Association and sample copies of its journals may be secured from the office of the Permanent Secretary of the Association in the Smithsonian Institution Building, Washington, D. C.

BIBLIOGRAPHY OF BIBLIOGRAPHIES

On Chemistry and Chemical Technology 1900–1924

In a Bulletin compiled by Clarence J. West and D. D. Berolzheimer for the Research Information Service of the National Research Council are 308 pages of listings of bibliographies on chemistry and chemical technology. To prepare a bibliography of bibliographies of this size was a task so large there is no reason to wonder why it is not more exhaustive. The authors deserve unstinted praise. They have given chemists and chemical technologists a reference library which no ceramist can afford to be without.

Quoting in part their introduction: "As a rule bibliographies are not issued as separate publications but are found as footnotes or appendices to books and to articles in the various scientific publications. Although a few of these lists may be located through abstract journals or through the bibliographical entries on the Library of Congress cards, most of them are not to be discovered by consulting the ordinary sources of information available to the research worker."

This bibliography is divided into five parts, (1) list of general bibliographies, (2) list of general abstract journals and year books, (3) partial lists of collective serials, (4) bibliographies on special subjects, and(5) list of personal bibliographies.

The bibliographies of special interest to ceramists cover (1) abrasives, (2) aluminum compounds among them the silicates, (3) bauxite, (4) bentonite, (5) boracic acid, borax and borates, (6) brick, (7) calcium and calcium compounds, (8) calorimetry, (9) carbides, (10) cement, (11) ceramics, (12) chromium, (13) clay, (14) coal, (15) cobalt, (16) colloids, (17) color and colorimetry, (18) copper, (19) corundum, (20) dental cements, (21) dolomite, (22) drying, (23) enamels, (24) feldspars, (25) fluorspar, (26) glass, (27) glass sands, (28) gypsum, (29) electric insulation, (30) iron and iron compounds, (31) kaolin, (32) Kieselguhr, (33) lead and lead compounds, (34) leucite, (35) magnesium and magnesium compounds, (36) manganese and manganese compounds, (37) mica, (38) minerals and mineralogy, (39) nickel and nickel compounds, (40) phosphates, (41) plasticity, (42) porcelain, (43) potash and potash compounds, (44) quartz, (45) refractories, (46) rutile, (47) sand lime brick, (48) selenium and selenium compounds, (49) silica and silicates, (50) silicon, (51) sodium and sodium compounds, (52) thermo properties, (53) tin, (54) titanium, (55) viscosity, (56) zeolites, (57) zinc and zinc compounds, (58) zirconium.

Price $2.50. Orders accompanied by remittance should be addressed to Publication Office, National Research Council, Washington, D. C.—EDITOR.

NEW CERAMIC ENGINEERING COURSES OFFERED BY CORRESPONDENCE

North Carolina State College, Raleigh, announces that a sufficient number of students have registered in the following correspondence courses in Ceramic Engineering to make them immediately available.

Cer. E.—102 Physical Geology. Fee $5.00
Cer. E.—103A Occurrence and Properties of Clays. Fee $7.50
Cer. E.—208D Pyrometry. Fee $2.50

The course in Physical Geology is a beginning course in Geology designed to prepare a student for the study of clays. The course includes several lectures on Historical and Economic Geology.

The course in Occurrence and Properties of Clays gives the student a complete set of lectures on this subject, a knowledge of which is so essential for the proper understanding of the various clay working processes.

The course in Pyrometry is probably the most complete set of lectures on the subject of Thermometry and Pyrometry that has ever been offered. Every phase of these subjects from the invention of the first thermometer to the modern pyrometer installations of the present day is completely covered. This course will be found of great value to all those dealing with temperature control, whether connected with the ceramic or other industries using heat processes.

It is the intention of Professor A. F. Greaves-Walker to prepare additional courses as fast as the demand is presented. Eventually it is anticipated that practically the entire ceramic field will be covered.

Bulletin will be sent upon request.

CALENDAR OF CONVENTIONS

Organization	Date	Place
Am. Assn. Advancement of Science	Dec. 28–Jan. 2	Kansas City, Mo.
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 8–13, 1926	Atlanta, Ga.
(Fall Meeting)	Oct. 1, 1925	New York City

Organization	Date	Place
Am. Electrochemical Society	Sept. 24–26, 1925	Chattanooga, Tenn.
Am. Engineering Council	Jan., 1926	
Am. Foundrymen's Association	Oct. 5–9, 1925	Syracuse, N. Y.
Am. Gas Association	Oct. 12–16, 1925	Atlantic City, N. J.
Am. Inst. of Min. and Met. Engineers	Aug. 31–Sept. 5, 1925	Salt Lake City, Utah
Am. Soc. of Mechanical Engineers	Nov. 30–Dec. 3, 1925	New York City
Am. Zinc Institute	April 27–28, 1926	St. Louis, Mo.
Assn. Iron and Steel Elec. Engineers	Sept., 1925	Philadelphia, Pa.
Coal Mining Institute of America	Dec. 9–11, 1925	Pittsburgh, Pa.
Common Brick Manufacturers Assn.	Feb. 22–26, 1926	New Orleans, La.
Mining and Met. Society of America	Jan. 12, 1925	New York City
Natl. Association of Manufacturers	Oct. 26–28, 1925	St. Louis, Mo.
Natl. Brick Manufacturers Assn.	Nov. 2–7, 1925	St. Louis, Mo.
Natl. Exposition of Power and Mechanical Engineers	Nov. 30–Dec. 5, 1925	New York City
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City
Natl. Paving Brick Mfrs. Assn.	Jan., 1926	
Natl. Safety Council	Sept. 28–Oct. 2, 1925	Cleveland, O.
Optical Society of America	Oct., 1925	Ithaca, N. Y.
Sand-Lime Brick Association	Feb. 9–15, 1926	New Orleans, La.
Natl. Society for Vocational Education	Dec. 3–5, 1925	Cleveland, Ohio
Natl. Exposition of Coal Mining Machinery	Dec. 2–5, 1925	Cincinnati, O.

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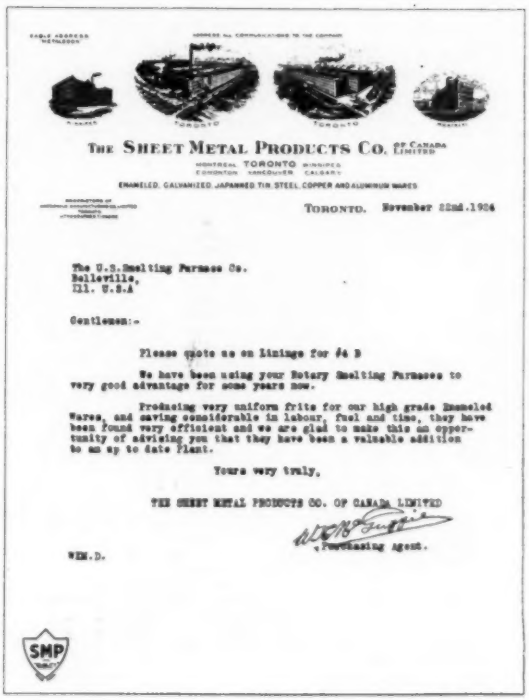

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BUYERS' GUIDE

A

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Auger Machines
Chambers Brothers Co.

Automatic Brick Machinery
Lancaster Iron Works, Inc.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

B

Ball Mills
Hardinge Co.
McDanel Refrac. Porcelain Co.
Mueller Machine Co., Inc.

Batts (Alundum-Crystolon)
Norton Co.

Bitstone
Potters Supply Co.

Bituminous Coal
Seaboard Fuel Corp.

Blocks (Refractory)
Norton Co.

Boats, Combustion
Norton Co.

Borax
American Trona Corp.
Innis, Speiden & Co.

Boric Acid (Crystal, Granular or Powder)
American Trona Corp.
Innis, Speiden & Co.

Brick Making Machinery
Chambers Brothers Co.

Bricks (Refractory-Alundum-Crystolon)
Norton Co.

Burners (Oil)
Best, W. N. Corp.

C

Cars (Clay)
Lancaster Iron Works, Inc.

Carbonates (Barium-Lead)
Innis, Speiden & Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Cements
Norton Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co..

Ceramic Plant Equipment
Ceramic Engineering Co.
Chambers Brothers Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Ball)
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co.
Potters Supply Co.
United Clay Mines Corp.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical—Porcelain)
Edgar Brothers Co.
Harshaw, Fuller & Goodwin Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Paper Makers Importing Co.
Metal & Thermit Corp.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Potters Supply Co.
United Clay Mines Corp.

Clay (Potters)
Paper Makers Importing Co.
United Clay Mines Corp.

Clay (Sagger)
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Potters Supply Co.
United Clay Mines Corp.

Clay Cleaning Machinery
Lancaster Iron Works, Inc.

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Newark Wire Cloth is made for every service from such malleable metals as: aluminum, brass, copper, bronze, phosphor bronze, nickel, steel, gold, silver, platinum, nichrome, monel metal, and special alloys.

Accuracy and uniformity are the chief characteristics that distinguish Newark Wire Cloth. It is made with great care and precision.

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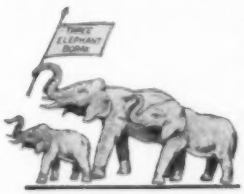

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BUYERS' GUIDE (continued)

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Clay Miners
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay Storage Systems
Lancaster Iron Works, Inc.

Clay (Wad)
Paper Makers Importing Co., (Inc).
Potters Supply Co.
United Clay Mines Corp.

Clay (Wall Tile)
Paper Makers Importing Co., (Inc).
United Clay Mines Corp.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Cloth (wire)
Newark Wire Cloth Co.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Cones (Filter)
Norton Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Belt) (Cable)
Lancaster Iron Works, Inc.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Mueller Machine Co., Inc.

Controllers, (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Harshaw, Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.

Crucibles (Filter-Melting-Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

D

Decorating Supplies
Caulkins & Co., H. J.
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Decorating Kilns
Caulkins & Co., H. J.
Holcroft & Co.

Dental Furnaces
Caulkins & Co., H. J.

Discs (Alundum-Porous-Filter)
Norton Co.

Dishes (Alundum-Filtering-Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Dolomite
Innis, Speiden & Co.

Dryers (China Ware—Porcelain)
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Dryers (Steam Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

E

Electrical Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Electric Co. Meters (Recorders)
Brown Instrument Co.
Engelhard, Chas., Inc.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.

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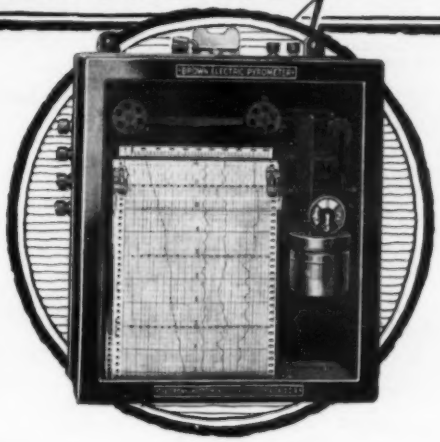

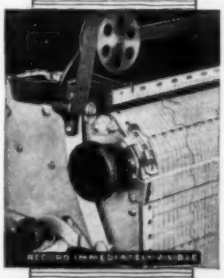

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TITLE _____
COMPANY _____
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Enameling Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
Combustion Utilities Corp.
Ferro Enamel Supply Co.
General Electric Co.
Holcroft & Co.
Surface Combustion Co.
The Carborundum Co.
(*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.
Vitro Mfg. Co.

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
Parker-Russell Mining & Mfg. Co.
The Carborundum Co.
(*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Tefft, C. Forrest

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Feldspar
Drakenfeld and Co., B. F.
Eureka Flint & Spar Co.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co. (*Isco*)
Maine Feldspar Co.
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker-Russell Mining & Mfg. Co.
The Carborundum Co.

Flint
Eureka Flint & Spar Co.
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co. (*Carrara*)
National Silica Co.
Pennsylvania Pulverizing Co.

Frit
Ferro Enamel Supply Co.
Porcelain Enamel & Supply Co.
Vitro Mfg Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Caulkins & Co., H. J.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Holcroft & Co.
Parker-Russell Mining & Mfg. Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
Engelhard, Chas., Inc.
General Electric Co.
Holcroft & Co.

G

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Granulators
Lancaster Iron Works, Inc.

Gold
Drakenfeld, and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

H

Hearths
The Carborundum Co.
(Carbofrax heat treating)

Hygrometers (Electric)
Engelhard, Chas., Inc.

I

Impervite (Refractory and Hard Porcelain)
Engelhard, Charles, Inc.

Infusorial Earth
Innis, Speiden & Co.

Iron (Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

Uniformity in Enameling Sheets Reduces Culls

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The Purest Iron Made
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(American Ceramic Journal—Sept., 1925)

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J

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

K

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Kilns (china, decorating)
Caulkins & Co., H. J.
Holcroft & Co.

Kiln Castings
Lancaster Iron Works, Inc.

Kryolith
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

L

Lehrs (Electric)
General Elec. Co.

Linings (Furnace-Refractory Block-Refractory Plate, Brick and Tile)
Norton Co.
The Carborundum Co.

M

Magnesite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Manganese
Harshaw, Fuller & Goodwin Co.
Hy-Grade Manganese Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

Mills (*See under Ball Mills*)
(*See under Pebble Mills*)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Moulds (Brick)
Lancaster Iron Works, Inc.

Muffles (Furnace)
Norton Co.
The Carborundum Co. (*Carbofrax*)

Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

N

Nitrates (Cobalt, Sodium)
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

O

Oil Burners
Best, W. N. Corp.

Opacifiers
Harshaw, Fuller & Goodwin Co.
Titanium Alloy Mfg. Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pins
Potters Supply Co.

Placing Sand
Pennsylvania Pulverizing Co.
National Silica Co.
United Clay Mines Corp.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.

Plates (Filter)
Norton Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Potash (Carbonate)
Innis, Speiden & Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

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A Zirconium Oxide so constituted physically and chemically that it

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WHITE

Enameled Products of all types are today being produced on a large scale by using OPAX exclusively. Standard in every respect as to Opacity and Whiteness

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Certainty that the opacity will stay "put", even with overfiring. It cannot be reduced.

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Certainty that it will lower your costs.

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Chambers Brothers Co
Hadfield-Penfield Steel Co.
Lancaster Iron Works, Inc.
Mueller Machine Co., Inc.

Pulverizing Machinery
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Pyrometers (Recording)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Pyrometer (Switches)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

R

Recording Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Recuperators
The Surface Combustion Co.

Refractories
The Carborundum Co.
Norton Co
United Clay Mines Corp.

Refractory Materials
Parker-Russell Mining & Mfg. Co.
United Clay Mines Corp.

Regulators (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

S

Saggers
The Carborundum Co.
Norton Company
Potters Supply Co.

Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.
Watson-Stillman Co.

Screens
Newark Wire Cloth Co.

Selenite of Sodium
Drakenfeld and Co., B. F.
Harshaw, Fuller & Goodwin Co.
Vitro Mfg. Co

Shippers (Coal)
Seaboard Fuel Corp.

Silica Brick
Parker-Russell Mining & Mfg. Co.

Silex Lining
Hardinge Co.

Sillimanite (Synthetic)
Norton Co.

Slabs (Furnace)
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Parker-Russell Mining & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Soda Ash
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Sodium Antimonate
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corporation
Vitro Mfg. Co.

Sodium Fluoride
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Spar
Eureka Flint and Spar Co.
Harshaw, Fuller & Goodwin Co.
Maine Feldspar Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld and Co., B. F.
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Roessler and Hasslacher Chemical Co

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Special for Glassmakers and Potters
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Tachometers
Brown Instrument Co.

Talc
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Tanks
Lancaster Iron Works, Inc.

Temperature Instruments (Measuring)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermometers (Electric Resistance)
Brown Instrument Co.
Engelhard, Charles, Inc.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Tin Oxide
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.

Titanium
Titanium Alloy Mfg. Co.

Tubes (Insulating)
Engelhard, Chas., Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co.
Engelhard Charles, Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

V

Vacuum Pumps
Mueller Machine Co., Inc.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Winding Drums
Lancaster Iron Works, Inc.

Witherite
Harshaw, Fuller & Goodwin Co.
Innis, Speiden & Co.

Z

Zirconia
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

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EDGAR PLASTIC KAOLIN CO. LAKE COUNTY CLAY CO.

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How much would better refractories save for you?

THESE BULLETINS WILL INTEREST YOU

Each of these bulletins is a treatise on the Central of Georgia's extensive research work on Georgia Clays and Kaolins. They contain no elaboration—just the real facts of the superiority of Georgia Clays and other valuable information for those seriously interested in their exploitation or use. Write for any one of them, or all if you wish.

The utilization of Georgia Clays for refractories

Directory of Commercial Minerals in Georgia and Alabama along Central of Georgia Railway.

Washing Tests of Georgia Clays.

Georgia Clays for Paper Fillers.

Georgia Clays for Rubber Fillers.

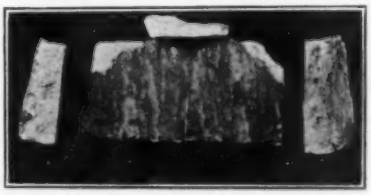
Use of Sedimentary Kaolins of Georgia in Whitewares.

Kaolin and Refractory Clay Deposits in Wilkinson Co., Ga.

Utilization of Georgia Kaolins for Refractories.

Distribution of Kaolin and Bauxite of the Coastal Plain of Georgia.

AFTER all, no matter how modern and expensive your electric furnace or similar furnace equipment may be, its economical and efficient operation is dependent to no small degree upon its refractory linings. The best of present day refractories take their toll from profitable production as a result of production losses, through the need of frequent refractory replacements.



Brick made from Georgia Kaolin, removed from an electric furnace door at the end of the 62nd heat. Particularly notice that there is no penetration of slag.

In one steel plant alone, it is estimated this loss reaches the staggering sum of $2,000,000 annually. It is also estimated that better refractories would save at least $500,000 of this tremendous annual loss. GEORGIA KAOLIN REFRACTORIES will probably effect that saving in this plant in the near future.

Tests of refractory brick made from Georgia Kaolin have proven from 29 to 220 per cent better than silica and special fire clay brick for use in electric furnaces and 266 per cent better in open-hearth furnace ladles. Its value in open-hearth furnaces has not yet been fully determined, but if results of tests here stated are any indication of the possibilities, Georgia Kaolin brick will give equally as efficient service as an open-hearth refractory.

Consider the saving, the greater service from Georgia Kaolin Refractories, can effect in your plant. See that your future refractory material is made from Georgia Kaolin.

The use of Georgia Kaolin for refractory brick is a comparatively new development. There is abundant opportunity to establish a large and prosperous industry here. Many desirable undeveloped properties are available. The Central of Georgia Railway has made a careful survey of many deposits in this territory and is in position to furnish valuable suggestions to those interested.

American Ceramic Society Annual Convention, Atlanta, February 8-13, 1926

Central of Georgia Railway

J. M. Mallory
Gen'l. Industrial Agent

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and their fabrication, receive the most publicity through the Journal.

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Special No. 6—Pottery

OIL or GAS

Pottery Kilns, China and Glass Decorating Kilns, Enameling Furnaces, Dental and other High Heat Furnaces.

Thousands choose the Revelation Kiln.

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TRENTON, N. J.

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This Month,
So We Are Going on
A
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The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

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UNUSUAL · SHAPES · OUR · SPECIALTY ·

HIGH GRADE
CLAYS
OF EVERY KIND—FOR EVERY PURPOSE
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for surface and body coloring. We pay special attention to our 200 mesh powder that will not "Cat Eye" in glazes.

We mine and very carefully prepare every pound of our own product.

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If you want pyrometer protection tube satisfaction
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All Sizes and Lengths for either Platinum or Base Metal Couples
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If the manufacturer of your pyrometer equipment cannot supply you, write us direct.
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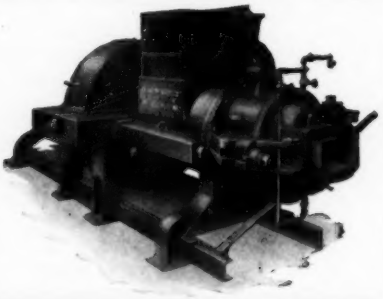

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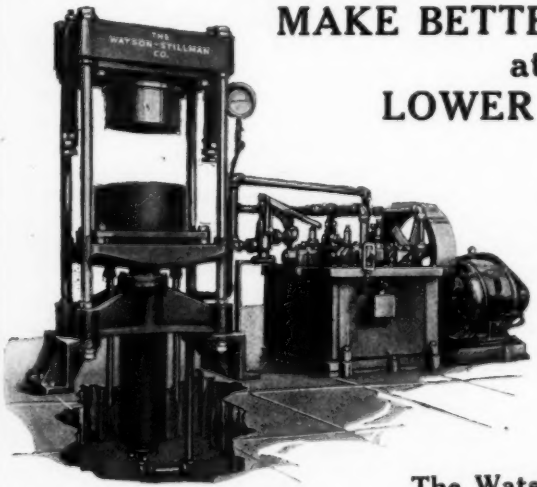

Showing a 50 Ton Sagger Press Outfit Complete equipped with dies for making Elliptical Sagger.

These Machines press saggers from solid wads of clay. Our sagger dies have no joints to work loose or open under pressure, this insures a homogeneous product and reduces to a minimum the losses in firing.

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The Ideal Opacifier

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FOR THE Enameling Glassware and Pottery Industries

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Write for catalogs and list of users in the Ceramic field

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1816 CHEMICALS 1925

"Over a Century of Service and Progress"

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FELDSPAR

An extremely high-grade Potash Spar ground in our own mills under constant and thorough chemical control.

Capacity up to 300 Tons Daily

We solicit your inquiries

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THE CERAMIC INDUSTRY'S BEST ASSET

BUILT RIGHT
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FOR CLAY WORKERS

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The Hadfield-Penfield Steel Co.
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ENGELHARD PYROMETERS
for
—TUNNEL KILNS—

Engelhard Pyrometers have many exclusive features that make them desirable for tunnel kilns, and they have been applied to almost every type of tunnel kiln.

A notable installation is on the Dressler Kiln at the Ford Motor Co's glass plant at Glassmere, Pa., which is used for pot heating for plate glass manufacture.

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Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

KARL LANGENBECK
Consulting Ceramic Engineer
1625 Hobart St., N. W., Washington, D. C.
Competent men for responsible
positions in the clay
industries, available.

Chemical Analyses of
Ceramic Materials
W. W. WILKINS
LEWIS INSTITUTE
1951 W. Madison St., Chicago, Ill.

CERAMIC BREVITIES

THE FERRO ENAMEL SUPPLY COMPANY announces the addition of Robert Roadhouse to their Service Staff. Mr. Roadhouse for many years had charge of the enameling department of the Benjamin Electric plant at Des Plaines, Ill.

THE FERRO ENAMEL SUPPLY COMPANY of Cleveland, Ohio is installing a Bonnot Overhead Charging Fork and Double Unloader in the enameling plant of the Malleable Iron Range Company, Beaver Dam, Wisconsin.

Final Inspection of
Toncan Enameling Sheets

It isn't what you pay, but what you get for your money that counts.

Irrespective of price it is the low cost of Toncan that makes it the most economical enameling base.

This low cost is a result of a substantially higher percentage of perfect pieces, a reduction of profit wasting culls.

The surface of Toncan is smooth, clean and free from scale, grease and dirt. It does not warp in the fusing operation.

Toncan is free from gas, blow-holes and laminations. It does not blister.

Toncan is stiffer at fusing temperature than ordinary iron. It does not sag between burning points.

If you have never used Toncan, a trial of this carefully made iron will give you a new slant on enameling profits.

TONCAN METAL

UNITED ALLOY STEEL CORPORATION
CANTON, OHIO

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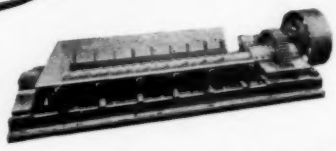
TONCAN ENAMELING SHEETS



This granulator is a valuable asset to any clay working plant. It will handle two or three cars of clay at a time and quickly earns its installation cost through savings in labor and repairs.

Write for full particulars today.

WHY YOU NEED THIS HEAVY DUTY GRANULATOR

Breaking up heavy lumps of clay subjects your clay working machinery to brutal punishment. The Lancaster Heavy Duty Granulator is designed to bear the brunt of this punishment and so protect your investment in auxiliary machinery.

This is a machine of tremendous strength and sturdiness. It breaks to fine particles the lumps of clay in the dry state, thoroughly mixes the clay to a uniform mass, and automatically feeds it to your additional clay preparing equipment.

Let Lancaster Engineers help solve your clay preparing problem.

LANCASTER IRON WORKS, Inc.
LANCASTER, PENNSYLVANIA
BRICK MACHINERY DEPARTMENT JAMES P. MARTIN, Manager

WABIK METAL
QUALITY M PRODUCTS

After an exhaustive study of the requirements of the Enameling Industry we are producing:

WABIK METAL SPECIAL VITREOUS ENAMELING SHEETS

Unlike ordinary steel sheets, warping and blistering is reduced to a minimum, thus increasing the Enameler's output and profit.

Many of the leading plants now recognize "WABIK METAL" as the supreme stock for that beautiful permanent lustre which is so essential in Table Tops, Stove Parts, Refrigerator Parts, Signs, etc.

THE MANSFIELD SHEET & TIN PLATE CO.
MANSFIELD, OHIO

SERVICE TO POTTERS

We Manufacture—	*We Sell—*
PINS	BALL CLAY
STILTS	SAGGER CLAY
THIMBLES	WAD CLAY
SPURS	GROUND FIRE CLAY
SAGGERS	BITSTONE
CRUCIBLES	FIRE BRICK
TILE for Decorating kilns	IMPORTED PARIS WHITE

THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

The National Silica Co.

OREGON, ILL.

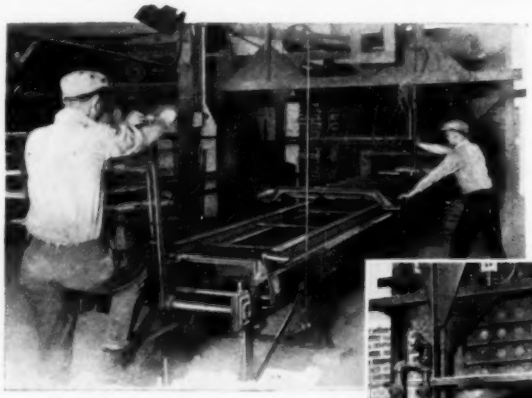
Producers and Pulverizers of

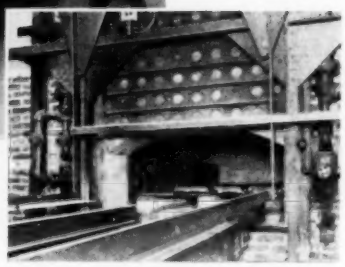
FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica ***140 Silk Lawn Test***





Fifty Per Cent More Production on Half the Fuel

THAT'S the record of a Carboradiant Furnace at the Prizer-Painter Stove Co. at Reading, Pa., in burning cast iron and steel stove parts.

With the old type furnace they averaged 10½ gallons of fuel per hour.

The Carboradiant Furnace uses but 5.4 gallons per hour and has jumped their production fifty per cent.

The Carboradiant Furnace heats by radiation. Perfect combustion takes place in two chambers of Carbofrax—the Carborundum refractory—placed one at each side of the furnace.

Because of the remarkable heat conductivity of Carbofrax the heat is quickly radiated to the working chamber—a clean, constant heat flow that is uniform from door to back wall.

The Carboradiant Furnace always insures better burned ware, increased production and fuel economy.

[Our Sales Engineering Department will gladly discuss this furnace with you]

THE CARBORADIANT FURNACE
HEATS BY RADIATION

THE CARBORUNDUM COMPANY, PERTH AMBOY, N. J.
REFRACTORY DIVISION

ENGLISH AND DOMESTIC

QUALITY

POTTING

CLAYS

Paper Makers Importing Co., Inc.
EASTON PENNA.

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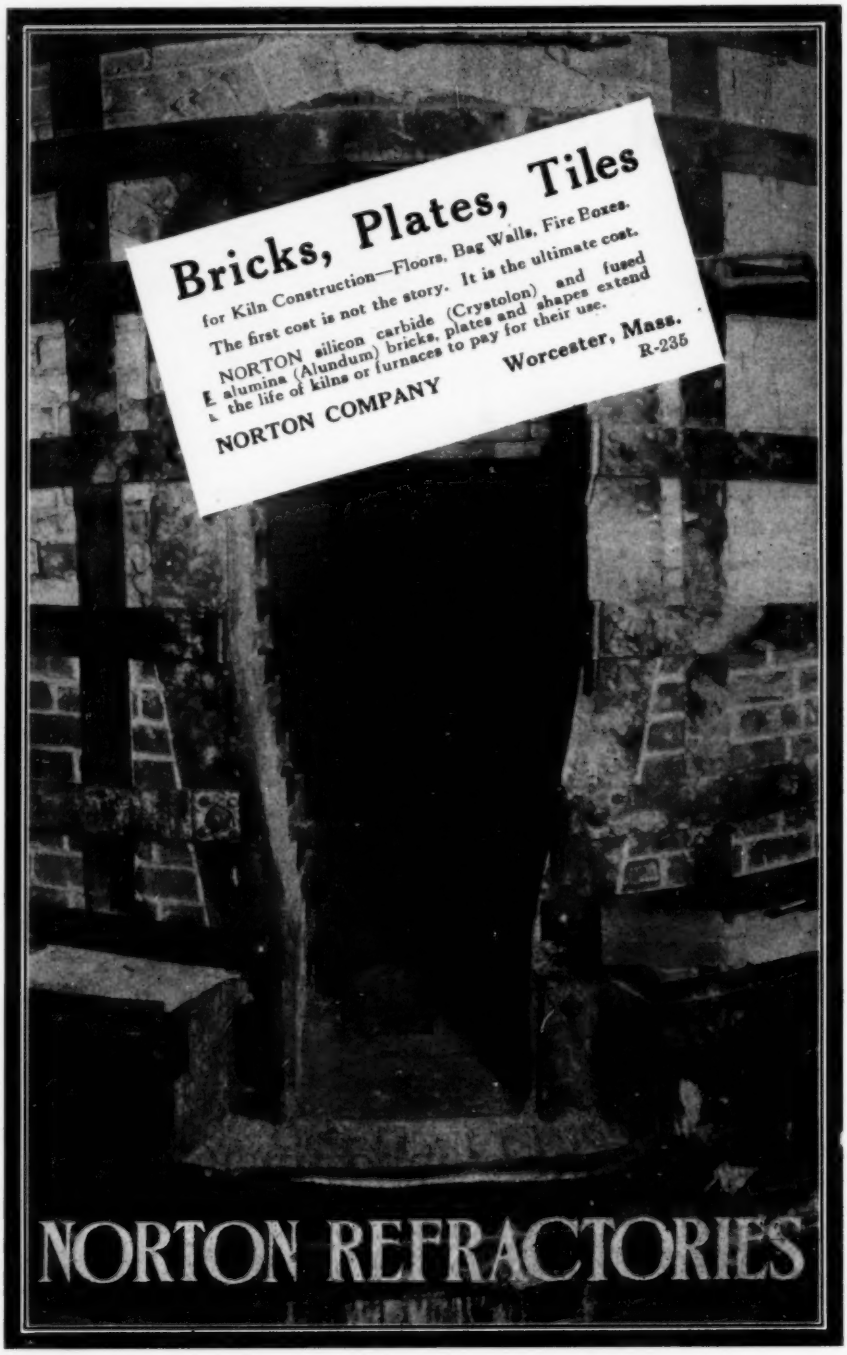
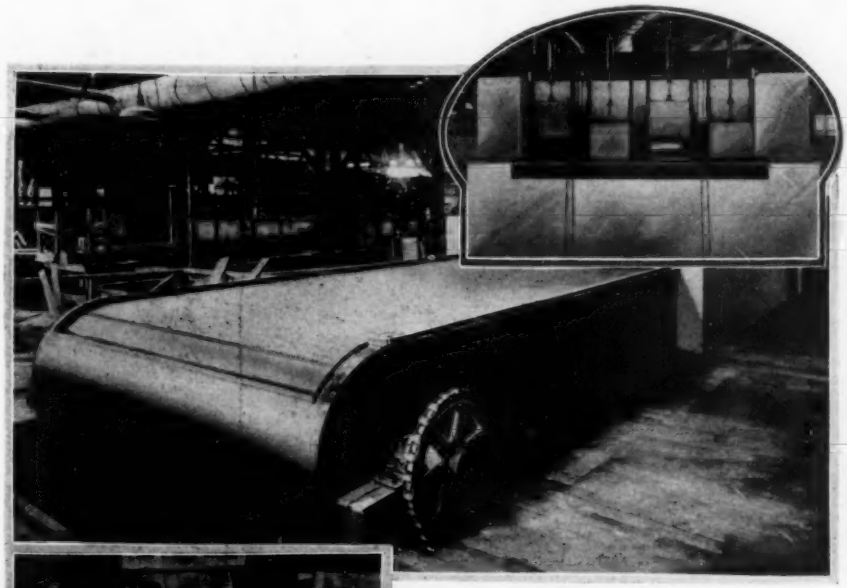

Bricks, Plates, Tiles
for Kiln Construction—Floors, Bag Walls, Fire Boxes.
The first cost is not the story. It is the ultimate cost.
NORTON silicon carbide (Crystolon) and fused alumina (Alundum) bricks, plates and shapes extend the life of kilns or furnaces to pay for their use.
NORTON COMPANY
Worcester, Mass.
R-235
NORTON REFRACTORIES



Absolute Temperature Control Improves Quality

An experimental electric lehr with a connected load of 125 Kw. was put in operation at the Illinois Pacific Glass Co. in 1921. Today, its factory is completely equipped with electric lehrs, and the results are revolutionary.

Positive temperature control within narrow limits throughout the annealing cycle is the key to the success of electric heat in this case. High thermal economy, ease of distribution and the elimination of breakage and rejects are incidental advantages.

The fact that the customers insist upon electrically annealed bottles proves their better quality.

Maintenance cost of the electric lehr has been negligible—$50 for 3 ½ years on the first lehr.

In this plant you find electric heat being used because it is cleaner and under absolute control; in other plants because of its greater flexibility, or some other feature. General Electric has pioneered in the development of electric heat. Let G-E engineers study your heating problems.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL LARGE CITIES

Guard Your Profits with "Hurricane" Machinery

Progressive concerns are interested in machinery that produces highest quality goods at largest profits. "HURRICANE" Machinery has stood this test for over a third of a century.

Simplicity Simplicity of construction prevents costly delays for repairs. Reliability of output assures continuous, profitable operation.

Reliability

Reputation "HURRICANE" Equipment has an unequalled reputation throughout the Textile Industry.

"HURRICANE" Machinery. A Quality Product producing a Quality Output.

Send for our complete listing of Ceramic Dryers

THE PHILADELPHIA DRYING MACHINERY COMPANY

Ceramic Drying Machinery

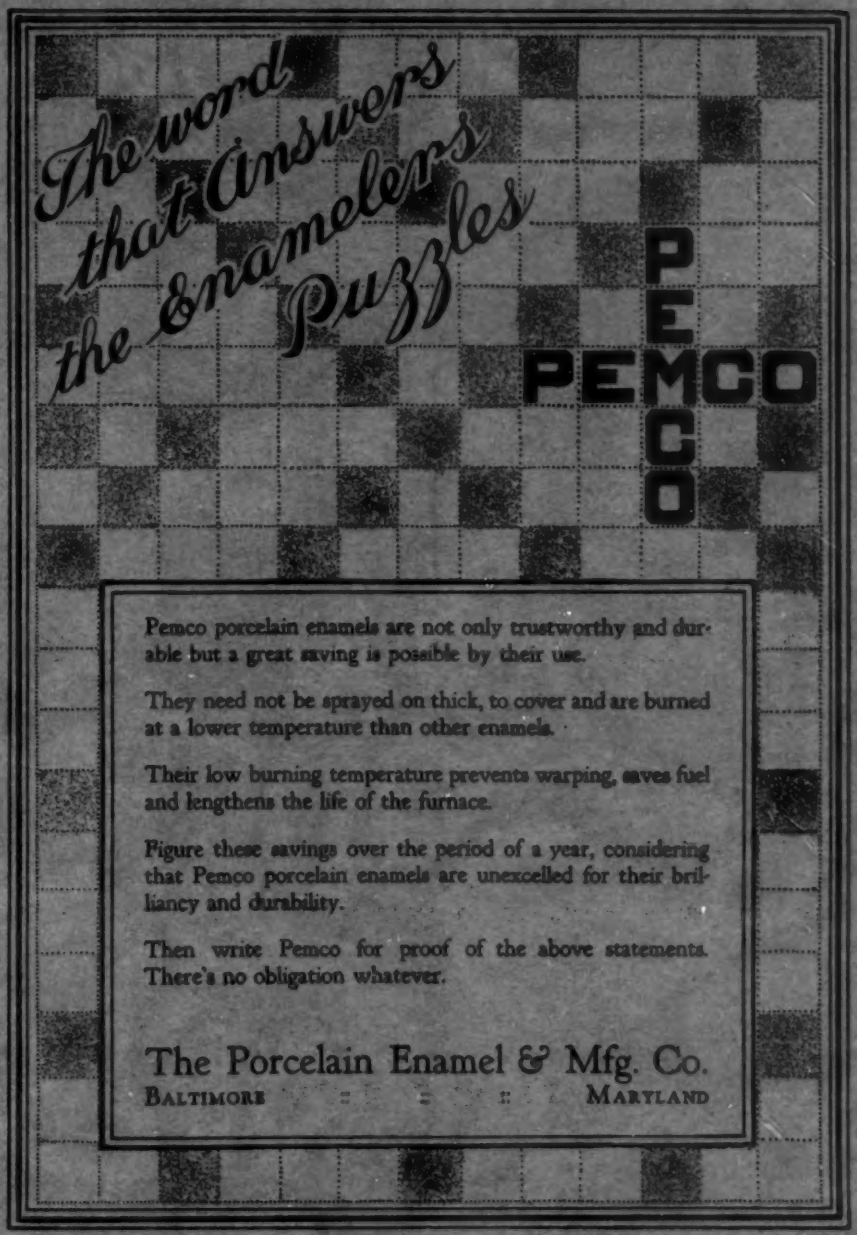
Stokley Street above Westmoreland

Philadelphia, Pa.

HURRICANE *Ideal Drying Every Day*

Canadian Agents: *Whitehead, Emmans, Ltd. Montreal*

New England Agency: *Hurricane Engineering Co. 53 State St., Boston, Mass.*



Pemco porcelain enamels are not only trustworthy and durable but a great saving is possible by their use.

They need not be sprayed on thick, to cover and are burned at a lower temperature than other enamels.

Their low burning temperature prevents warping, saves fuel and lengthens the life of the furnace.

Figure these savings over the period of a year, considering that Pemco porcelain enamels are unexcelled for their brilliancy and durability.

Then write Pemco for proof of the above statements. There's no obligation whatever.

The Porcelain Enamel & Mfg. Co.

BALTIMORE :: :: :: MARYLAND

M & T
TIN OXIDE

is preferred by foremost firms throughout the country, making terra cotta, faience, tiles, sanitary pottery and art pottery.

A uniform product, free from impurities, and with unexcelled covering power.

We welcome inquiries, and will gladly send samples for test purposes.

Exclusive Agents for

Johnson-Porter Enamel Clays

By giving exceptionally good results in floating enamel these clays are rapidly supplanting foreign enamel clays.

METAL & THERMIT CORPORATION

Ceramic Department
Homer F. Staley, Mgr.

120 Broadway
New York

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Vol. 8 SEPTEMBER, 1925 No. 9, Part II

Directory

of

Ceramic Materials

issued by

The American Ceramic Society

1925

Compiled and Issued by

Committee on Geological Surveys

R&H SERVICE

CERAMISTS
CHEMICALS
MINERALS & OXIDES

LIQUID BRIGHT GOLD
AND
GOLD AND SILVER PREPARATIONS

COLORS
ENAMELS,
UNDERGLAZE, OVERGLAZE
MAJOLICA, FLUX, MATT,
BODIES & OXIDES, GLASS,
LIQUID LUSTRE

THE
ROESSLER & HASSLACHER
CHEMICAL CO.
NEW YORK

Entered as second-class matter July 15, 1918, at the Post Office at Easton, Pa.
under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103,
Act of October 3, 1917, authorized August 16, 1918.

(Copyright 1925, American Ceramic Society)

DIRECTORY

of Ceramic Raw Materials, Supplies and Equipment

NO expense has been spared by the Society to make this, its second Directory of ceramic equipment and materials, as complete as possible. The first Directory was issued as a war help. Its scope was purposely limited.

Incomplete as this second Directory is, we believe it merits publishing at once. The demand for it is increasing. The time and page space required to make a ceramic directory complete would be out of proportion to the present essential needs. Completeness will no doubt be approached in later editions.

The listings in this edition are from questionnaires. We wish to acknowledge the coöperation given by the State Geologists from whom considerable information was obtained.

In many cases it was found advisable to list items under two or three headings but in all cases the producers or manufacturers were listed under the more commonly known terms.

Throughout this first edition will be found the advertisements of numerous companies—all of whom will gladly assist you in any problems within their province.

We wish to acknowledge the assistance of L. E. Geyer throughout the compiling and the preparation for printing of this Directory.

COMMITTEE ON GEOLOGICAL SURVEY

S. L. GALPIN H. RIES
ROBERT JONES W. G. WORCESTER
HEWITT WILSON

Chemicals and Raw Materials

Use this side of page for your memos.

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(See Grain)

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(Ceramic Specialists)
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General Chemical Co.
***Hanovia Chemical & Mfg. Co.**
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
***Roessler & Hasslacher Chemical Co.**
Stauffer Chemical Co.

AGATE
Foote Mineral Co., Inc.

ALUM
Atkins, Kroll & Co.
Eastman Kodak Co.
Pennsylvania Salt Mfg. Co.

ALUMINA
Aluminum Company of America
Baker, J. T. Chemical Co.
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
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Vitrefrax Co.

AMBLYGONITE
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ANDALUSITE
Caliproducts Co.
Champion Spark Plug Co.
Foote Mineral Co., Inc.
National Sales Corp.

ANHYDRITE
Centerville Gypsum Co.

ANTIMONY
Wiarda, John C. & Co.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

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Braun Corp.
Crystal, Chas. B. & Sons
Drakenfeld, B. F. & Co.
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.
***Roessler & Hasslacher Chemical Co.**
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***Vitro Mfg. Co.**

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ASBESTOS

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(See Feldspar)

BADGER BLUE

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American Encaustic Tiling Co.
Balfour Guthrie Co.
Brinkman, S. G.
Butler, E. L. Clay Company
Chicago Crucible Company
Cooley Clay Company
Coors, H. F.
Edgar Plastic Kaolin Co.
English China Clay Sales Corp.
Enterprise White Clay Co.
Excelsior Ball Clay Co.
Florida China Clay Co.
***Franzheim, Chas. M. Company**
Frost, G.
***Golding Sons Co.**
Hammill and Gillespie, Inc.
Harshaw, Fuller and Goodwin Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Hickory Ball Clay Co.
Higman, John W. Company
Johnson-Porter Clay Company, The
Kentucky Clay Mining Co.
Kentucky Construction and Improvement Co.
Knowles, Luke
Laclede-Christy Clay Products Co.
McHose, L. H.
Mandle Clay Mining Co., The
Metal and Thermit Corporation
Moore and Munger
National Sales Corporation
O'Leary, T. A. Company
Old Hickory Clay and Talc Co.
Paducah Clay Co.
***Paper Makers Importing Co.**
Pike, L. G.
Poole, Joshua
Potters Supply Co.
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Sant, Thos. H. & Son Co.
Tamms Silica Co.
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BALL CLAY
(English)

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***Golding Sons Co.**
Hammill & Gillespie, Inc.
Moore & Munger
***Paper Makers Importing Co.**
Richardson, John, Co.
***Sant, John and Sons Co.**
Sant, Thos. H. and Son Co.
***United Clay Mines Corp.**
Wengers, Ltd.

BARITE

Illinois Barite Co.
Lavino, E. J. Co.
National Sales Corp.
Product Sales Co.
Salomon, L. A. & Son

BARIUM CARBONATE

Clinchfield Products Co.
Chicago Copper & Chemical Co.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
Mineral Point Zinc Co.
New Jersey Zinc Sales Co.
Pitts & Laughlin Co.
Robins, G. S., Co.
***Roessler & Hasslacher Chemical Co.**
Rollin Chemical Co.
Rolls, H. J., Co.
Schall Color & Chemical Co.
Suter, Eugene, & Co.
Uhlich, Paul, & Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

"Quality" our motto, with 60 years' experience for our guidance.

PIONEERS AND LARGEST DEALERS IN

Pottery, Tile, Sanitary Porcelain
and Glass Mfrs' Supplies.

Producers and Dealers in

FELD-SPAR, Body and Glaze Spar
FLINT, French, Rock, and Sand Flint
CORNWALL STONE, High-Grade, Hard Purple Rock

CLAYS

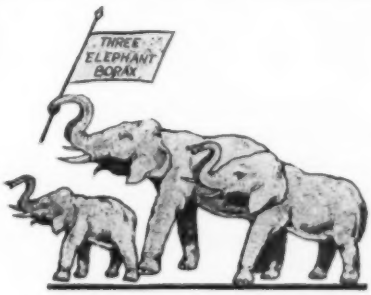
Delaware China, No. 1 and No. 2
Georgia China and Sagger Clay

Golding Sons' Company

Established 1865

Works: Trenton, N. J. Hockessin, Del. East Liverpool, Ohio
Wilmington, Del. Butler, Ga. Erwin, Tenn.

ITS uniform high quality guarantees the excellence of your product.



Write for our Price and samples today

We also make Boric Acid guaranteed 95.5% pure

AMERICAN TRONA CORPORATION

Woolworth Bldg., New York, N. Y.

THREE ELEPHANT BORAX 99.5% PURE

BATHITE
White Heat Products Co.

BAUXITE
*Central of Georgia Ry. (J. M. Mallory)
Mississippi Bauxite Co.
National Sales Corp.
Pennsylvania Salt Mfg. Co.
Tennant, C. & Sons Co.

BENTONITE
Atkins, Kroll & Co.
Bacon, H. W.
Bentonite Products Co.
Forney, A. C.
Haze, Harry S.
Homestake Mining Co.
Logan, Thos. O.
Mowrey, C. W.
National Sales Corp.
Oywhee Chemical Co.
Robinson, Griff.
Sly, E. M.
Tennant, C. & Sons Co.

BERYL
Foote Mineral Co., Inc.

BERYLLIUM ALUMINATE
Foote Mineral Co., Inc.

BIOTITE
Foote Mineral Co., Inc.

BISMUTH
Baker, J. T. Chemical Co.
Foote Mineral Co., Inc.
Mallinckrodt Chemical Works
Powers-Weightman-Rosengarten Co.

BITSTONE
Crystal, Chas. B. & Sons
Eureka Flint & Spar Co.
*Franzheim, Chas. M. Company
Hammill & Gillespie, Inc.
Maryland Quartz Co.

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BOND CLAY

Bausch, Fred E.
Bell, Fred S.
Bree, W. A.
*Central of Georgia Ry. (J. M. Mallory)
*General Refractories Co.
Harbison-Walker Refractories Co.
Hickory Ball Clay Co.
Johnson-Porter Clay Co.
Laclede-Christy Clay Products Co.
Mitchell Clay Manufacturing Co.
*Paper Makers Importing Co.
*Sant, John and Sons Co.
Sant, Thos. H. & Son Co.
*United Clay Mines Corp.
*Vanderbilt, R. T. & Co.

BONE ASH

Drakenfeld, B. F., & Co.
Harshaw, Fuller & Goodwin Co.
Robins, G. S., Co.
*Roessler & Hasslacher Chemical Co.
Wishnick-Tumpeer Co.

BORATES

Mallinckrodt Chemical Works

BORAX AND BORIC ACID

*American Trona Corp.
Bailey Drug Co.
Braun Corp.
Daigger, A. & Co.
Drakenfeld, B. F., & Co.
Lynn, William, & Co.
Pacific Coast Borax Co.
Pfizer, Chas., & Co.
Robins, G. S., Co.
*Roessler & Hasslacher Chemical Co.
Sterling Borax Co.
Suckow Chemical Co.
Thorkildsen-Mather Co.
Union Borax Co.
Wiarda, John C., & Co.
Wishnick-Tumpeer Co.

BRUCITE

Northwest Magnesite Co.

BUFF CLAY

Butler, E. L. Clay Co.

CADMIUM ORANGE

*Vitro Mfg. Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

THE JOHN SANT & SONS CO.

EAST LIVERPOOL, OHIO

Miners - - Shippers - - Dealers

Pulverized Georgia Kaolin.
North Carolina Feldspar.

TENNESSEE
Ball, Saggar & Wad Clay

PENNSYLVANIA
Refractory Saggar Clay

Satisfactory Service and Material Guaranteed

Your Inquiries Solicited

Quality Uniformity Service

LUSTERLITE ENAMELS

Manufacturers

FURNACES - - SPEED FORKS - - ENAMELS

Complete Enamel Shop
Supplies & Equipment

STOCK CARRIED

Chicago Vitreous Enamel Product Co.

1407-47 S. 55th Court,
Cicero, Ill., U. S. A.

CADMIUM SULPHATE
Drakenfeld, B. F., & Co.
Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chemical Co.**

CADMIUM SULPHIDE
Drakenfeld, B. F., & Co.
Harshaw, Fuller & Goodwin Co.
Ransome, C. E. & Co.
***Roessler & Hasslacher Chemical Co.**
***Vitro Mfg. Co.**
Wengers, Ltd.

CALCITE
International Lime Co.
National Sales Corp.
Orcas Lime Co.
Roche Harbor Lime Co.

CALCIUM CARBONATE
***Franzheim, Chas. M., Co.**
Harshaw, Fuller & Goodwin Co.
Katzenbach & Bullock Co.
***Roessler & Hasslacher Chemical Co.**
Robins, G. S., Co.
Taintor Co., The

CALCIUM FLUORIDE
(See also Fluorite)
Atkins, Kroll & Co.
Foote Mineral Co., Inc.
Lavino, E. J. Co.
National Sales Corp.

CALCOTHAR
Harshaw, Fuller & Goodwin Co.

CARBORUNDUM
(See Silicon Carbide)

CARNITITE
Foote Mineral Co., Inc.

CELESTITE
Foote Mineral Co., Inc.

CERIUM HYDRATE
Lindsay Light Co.

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UNITED CLAY MINES
CORPORATION

Miners of

HIGH GRADE CLAYS

OF EVERY KIND—FOR EVERY PURPOSE

TRENTON, N. J.

Florida China Clay
New Jersey Fire Clays
Maryland Bond Clay
Georgia Washed Kaolin
Penna. & Georgia Sagger Kaolins
English China & Ball Clays
Etc. Etc.

WAREHOUSE STOCK OF ALL KINDS OF CLAY
CARRIED IN TRENTON & EAST LIVERPOOL

We can make quick shipment
at all times, of 100 lbs. or 100 tons.

CERIUM HYDRATED OXIDE
Welsbach Co.

CERIUM NITRATE
Welsbach Co.

CERIUM OXIDE
Welsbach Co.

CHALCEDONY
(Agate)
Foote Mineral Co., Inc.

CHINA CLAY
American Encaustic Tiling Co.
American Grinding Co.
Balfour-Guthrie Co.
Cawood, Richard L., Co.
***Central of Georgia Ry.** (J. M. Mallory)
Coors, H. F.
Edgar Plastic Kaolin Co.
English China Clay Sales Corp.
Florida China Clay Corporation
***Franzheim, Chas. M. Company**
***Golding Sons Company, The**
Hammill and Gillespie, Inc.
Harris Clay Co., The
Harshaw, Fuller & Goodwin Co.
Higman, J. W. Company
Moore & Munger
National Sales Corp.
Newark China Clay Corp.
***Paper Makers Importing Co.**
Poole, Joshua
Richardson, John, Company
***Roessler & Hasslacher Chemical Co.**
***Sant, John, & Sons Company**
Sant, Thos. H. & Son Co.
Smith, Norman G., & Co., Inc.
***United Clay Mines Corp.**
***Vanderbilt, R. T. Co.**
Vermont Kaolin Co.
Wengers, Ltd.

CHINA CLAY
(English)
English China Clay Sales Corp.
***Franzheim, Chas. M. Co.**
***Golding Sons Co.**
Hammill & Gillespie, Inc.
Moore & Munger
***Paper Makers Importing Co.**
Richardson, John, Co.
***Sant, John and Sons Co.**
Sant, Thos. H. and Son Co.
***United Clay Mines Corp.**
Wengers, Ltd.

CHLORITE
Pennsylvania Salt Mfg. Co.

Use this side of page for your memos.

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KAOLIN, REFRACTORY CLAY AND BAUXITE BELT OF GEORGIA
SCALE
GEORGIA
Area of Clay Belt 225 miles long and from 20 to 50 miles in width.
Many of the deposits can be worked with little or no industrial haulage.

GEORGIA KAOLIN AND REFRACTORY CLAY

In fifteen counties in the Coastal Plain, all contiguous to the Central of Georgia Railway, there are abundant deposits of clays to meet the requirements of any particular industry.

The cost of mining is exceptionally small—because the overburden is comparatively light and the thickness of the clays permit the use of steam shovels.

These clays are now being used largely in the manufacture of paper, cloth, textile, oil cloth, paint, rubber, wall plaster, pottery, floor and wall tile, porcelain, sanitary ware.

Literature describing the deposits and reports giving the results of research work are available to those interested.

Deposits range from ten to forty feet in thickness and extend over an area of two hundred and twenty-five miles long and from twenty to fifty miles wide constituting the largest clay belt in Eastern United States.

Many choice properties are still awaiting development. To those interested, the Central of Georgia Railway will gladly lend every assistance in the selection of suitable locations.

The Central of Georgia Railway cooperating with the U. S. Bureau of Mines has made a thorough survey of the deposits of the Coastal Plain and has conducted laboratory and plant tests to determine the commercial values of the various clays found throughout this region.

Write for These Bulletins:

Directory of Commercial Minerals in Georgia and Alabama along Central of Georgia Railway.

Refractory Possibilities of Some Georgia Clays.

Use of Sedimentary Kaolins of Georgia in Whitewares.

Kaolin and Refractory Clay Deposits in Wilkinson Co., Ga.

Washing Tests of Georgia Clays.

Georgia Clays for Paper Fillers.

Georgia Clays for Rubber Filler.

Utilization of Georgia Kaolins in the manufacture of Face Brick.

Distribution of Kaolin and Bauxite of the Coastal Plain of Georgia.

Central of Georgia Railway

J. M. MALLORY,
General Industrial Agent

233 West Broad St.
Savannah, Ga.

CHROMATE OF IRON

American Encaustic Tiling Co.
Harshaw, Fuller & Goodwin Co.
*Roessler & Hasslacher Chemical Co.

CHROMITE

(Chrome Ore, Etc.)

Foote Mineral Co., Inc.
*General Refractories Co.
Harbison-Walker Refractories Co.
Lavino, E. J. Co.
National Sales Corp.

CHROMIUM OXIDE

Cawood, Richard L. Co.
Drakenfeld, B. F., & Co.
Harshaw, Fuller & Goodwin Co.
National Sales Corp.
*Roessler & Hasslacher Chemical Co.

COBALT

(Carbonate—Nitrate)

Drakenfeld, B. F. & Co.

COBALT OXIDE

Central Scientific Co.
Drakenfeld, B. F. & Co.
*Ferro Enamel Supply Co., The
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
*Roessler & Hasslacher Chemical Co.
Wengers, Ltd.

COBALT PHOSPHATE

Drakenfeld, B. F. & Co.
*Roessler & Hasslacher Chemical Co.

COBALT SULPHATE

*Roessler & Hasslacher Chemical Co.

COLORED CLAYS

Penn Tile Works Co., Inc.

COLORED OXIDES

Cawood, Richard L. Co.
Drakenfeld, B. F. & Co.
*Ferro Enamel Supply Co., The
Harshaw, Fuller & Goodwin Co.
Hommel, O. Co.
Metal & Thermit Corp.
Mine & Smelter Supply Co.

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* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

"Hanovia Supremacy Continues"

For the last twenty years it has been our aim to provide the American manufacturer and decorator of pottery and glass with decorating materials of the highest standard. To achieve this, we always did, and shall in the future, strictly adhere to the principle that only the best is good enough.

We do not boast that our line comprises all and everything that the decorating shop requires, but every Hanovia product which is put on the market may be relied upon to be perfect, at least as nearly perfect as human endeavor can make it, and our unreserved guarantee stands behind it. We are proud to say that this is unanimously acknowledged by our many patrons.

Especially is this true of the following three important classes of decorating materials, which are so widely used throughout the industry, and are today, without question, considered to be the leading products of their kind:

HANOVIA LIQUID BRIGHT GOLD
HANOVIA LIQUID BURNISH GOLD
HANOVIA LUSTRE COLORS.

We also make:

LIQUID BRIGHT SILVER and PLATINUM
BURNISH SILVER, c. p. and prepared
LIQUID BRIGHT GREENGOLD
LIQUID GOLD BRONZE
LIQUID BRIGHT COPPER
BURNISH PLATINUM
ENAMEL or OVERGLAZE COLORS.

The latest addition to our list

HANOVIA BROWN GOLD c. p.

will make the finest Paste Gold of great covering capacity and high burnishing power, especially in connection with

HANOVIA THICK OIL

which prevents cracking or blistering.

Please write for complete catalog and price-lists to:

Hanovia Chemical & Manufacturing Co.

Factory & General Offices,
Chestnut St. & N. J. R. R. Ave.,
Newark, N. J.

New York Office
Charles Engelhard
30 Church St.,
New York, N. Y.

COLORING OXIDES

Buckman & Pritchard, Inc.
*Ferro Enamel Supply Co., The
*Hanovia Chemical & Mfg. Co.
Hy-Grade Manganese Co.
New Jersey Zinc Sales Co.
*Porcelain Enamel & Mfg. Co., The
Ramsden, C. E. & Co.
*Titanium Alloy Mfg. Co.
*Vitro Mfg. Co.
Wiarda, John C., & Co.

COLORS

Buckman & Pritchard, Inc.
*Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F. & Co.
*Ferro Enamel Supply Co., The
*Hanovia Chemical & Mfg. Co.
Harrison & Son
Hommel, O. Co.
Hy-Grade Manganese Co.
Lewis Institute
New Jersey Zinc Sales Co.
Ramsden, C. E. & Co.
*Roessler & Hasslacher Chemical Co.
*Titanium Alloy Mfg. Co.

COLORS
(Oxides)

*Ferro Enamel Supply Co., The
*Hanovia Chemical & Mfg. Co.
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.
National Sales Corp.
Reusche, L. & Co.
*Roessler & Hasslacher Chemical Co.
Wengers, Ltd.

CORNWALL STONE

American Encaustic Tiling Co.
Balfour-Guthrie Co.
Eureka Flint and Spar Co.
*Franzheim, Chas. M., Co.
*Golding Sons Company
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
*Pennsylvania Pulverizing Co.
Richardson, John & Company
*Roessler & Hasslacher Chemical Co.

CORUNDUM
(Emery)

Blue Corundum Mining Co.
Keystone Emery Mills
Lavino, E. J. Co.
Smith & Ellis

CRYOLITE

Harshaw, Fuller & Goodwin Co.
Import Chemical Co.
Los Angeles Chemical Co.
Metal & Thermit Corp.
National Sales Corp.
Pennsylvania Salt Mfg. Co.
*Roessler & Hasslacher Chemical Co.
Robins, G. S. Co.
Tennant, C. & Sons Co.
Wiarda, John C. & Co.
Wishnick-Tumpeer Co.

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CYANITE

McLanahan-Watkins Co.
Product Sales Co.

DIAMOND

Atkins, Kroll & Co.

DIASPORE CLAYS

*General Refractories Co.
Grey Brothers
Laclede-Christy Clay Prod. Co.
Mitchell Clay Manufacturing Co.
National Sales Corp.
Wysor, D. C.

DIATOMACEOUS EARTH

(See also Kieselguhr)

Adirondack Diatomaceous Earth Co.
Atkins, Kroll & Co.
Celite Products Co.
Florida Diatomite Co.
Foote Mineral Co., Inc.
Great Western Silica Co.
National Sales Corp.
Salomon, L. A. & Son
Western Diatomite Co.

DOLOMITE

Abel Magnesia Co.
Bickler Brothers
Cedarville Lime Co.
Dearborn's, H. Sons
Delta Contracting Co.
Dolese Brothers Co.
Dolomite Products Co.
Dunbar & Sullivan Dredging Co.
Eagle Point Lime Works
Ellis Park Stone Co.
France Stone Co.
Hurst, A. A. & Co.
Lavino, E. J. Co.
Linwood Cement Co.
Marquette Stone Products Co.
Metronite Co.
Morris, Sam W.
Northern Lime Co.
Ozark Stone Quarry
Scott Quarry Co.
White Marble Lime Co.

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Standard

Quality

VITRO PRODUCTS

ENAMELS

Cast Iron Enamels—for stoves and ranges. In white and all colors.

Steel Enamels—for sheet steel signs, kitchen ware, etc.

Sanitary Enamels—for bathtubs, sinks, tables, etc. Dry process.

CHEMICALS & SPECIALTIES

Vitrozircon—The ideal opacifier. Replaces oxide of tin at a fraction of cost.

Coloring Oxides—Intense and brilliant.

Chemicals—of exceptional grade. For all ceramic industries.

Your inquiries solicited

THE VITRO MANUFACTURING CO.

Pittsburgh, Pa.

ENAMEL CLAYS

Hammill & Gillespie, Inc.
Illinois Kaolin Co.
Johnson-Porter Clay Co.
Metal & Thermit Corp.
***Paper Makers Importing Co.**
Pike, L. G.
***Roessler & Hasslacher Chemical Company**
Sant, Thos. H. & Son Co.
***United Clay Mines Corp.**

ENAMELS, GLAZES, ETC.
(Prepared)

***Chicago Vitreous Enamel Product Co., The**
Federal Enamel Supply Co.
***Ferro Enamel Supply Co., The**
Lewis Institute
***Porcelain Enamel & Mfg. Co.**
***Vitro Mfg. Co.**

ENAMELS AND STAINS

Belleville Enameling & Stamping Co.
***Chicago Vitreous Enamel Product Co.**
O. Hommel Co.
Wengers, Ltd.
***Vitro Mfg. Co.**

EPSOM SALTS

Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chemical Co.**
Van Schaack, Peter & Son

FELDSPAR

Adirondack Spar Mining Co.
American Encaustic Tiling Co.
American Grinding Co.
Bedford Mining Co.
Cawood, Richard L. Co.
Cleveland Feldspar & Products Co.
Clinchfield Products Corporation
Cummings, J. W. Feldspar Co.
Dominion Feldspar Co.
Erwin Feldspar Corp.
Eureka Flint & Spar Co.
***Franzheim, Chas. M. Co.**
Frontenac Floor & Wall Tile Co.
***Genesee Feldspar Co.**
Golding-Keene Co.
***Golding Sons Co.**
Green Hill Mining Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Howe, L. W.
Industrial Minerals Corp., Ltd.
Innis, Speiden & Co.
Isco Bautz Co., Inc.
Johnson, Wm.
Kingman Feldspar Co.
Los Angeles Chemical Co.
***Maine Feldspar Co., The**
Mineral Products Co.
National Sales Corp., The

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PENNSYLVANIA PULVERIZING COMPANY

GENERAL OFFICE
LEWISTOWN
PENNSYLVANIA

SALES OFFICE
323 FOURTH AVE.,
PITTSBURGH, PA.

THE ACKNOWLEDGED STANDARD

FLINT

FELDSPAR

PLACING SAND

TO KEEP APACE WITH THE PROGRESS OF THE CERAMIC INDUSTRY—TWO LARGE MODERN GRINDING MILLS COMPLETED IN 1925.

QUALITY UNIFORMITY SERVICE

Non Metallic Minerals Corp.
North State Feldspar Co., The
O'Brien & Fowler
Onondaga Potteries Co.
Pacific Sanitary Mfg. Co.
Penland Feldspar & Kaolin Co.
***Pennsylvania Pulverizing Co.**
Perham, A. C.
Perris Mining Co.
Perth Feldspar & Mining Co.
Potters Mining & Milling Co.
Products Sales Co.
Ranstetter, Henry
River Feldspar & Milling Co.
Robins, G. S. Co.
***Roessler & Hasslacher Chemical Co.**
Rock Products Co.
***Sant, John and Sons Co.**
Sant, Thos. H. & Son Co.
Seaboard Feldspar Co.
Tennessee Mineral Products Co.
Trenton Flint & Spar Co.
United States Feldspar Corp.
Wengers Ltd.

FIRE AND PLASTIC FIRE CLAYS

Allen Bros.
Anness & Potter Fire Clay Co.
Ashland Fire Brick & Clay Co.
Bausch, Fred E.
Big Savage Fire Brick Co.
Bloomfield Clay Co., The
Crescent Refractories Co.
Denver Sewer Pipe & Clay Co.
Dover Fire Brick Co.
***General Refractories Co.**
Harbison-Walker Refractories Co.
International Silica Co.
Kier Fire Brick Co.
Laclede-Christy Clay Products Co.
Massillon Stone & Fire Brick Co.
Missouri Fire Brick Co.
Mitchell Clay Mfg. Co.
Reading Fire Brick Works
***United Clay Mines Corp.**
Western Stoneware Co.

FLINT

(See Quartz)

FLINT FIRE CLAYS

Crossman Co.
Dee, Wm. E.
Denver Fire Clay Co.
Dickey, W. S. Clay Mfg. Co.
Dixie Fireproofing Co.
Edgar Brothers
Elk Fire Brick Co.
Enterprise White Clay Co.
Farber Fire Brick Co.
Federal Clay Prod. Co.
Garfield Fire Clay Co.
Gates Fire Clay Co.
***General Refractories Co.**
Grand View Fire Clay Co.
Green, A. P. Fire Brick Co.
Hammill & Gillespie, Inc.
Harbison-Walker Refractories Co.
Hayes Run Fire Brick Co.

Use this side of page for your memos.

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica ***140 Silk Lawn Test***

Genesee Canadian Feldspar

Eliminate the Guess Work
Use Genesee Feldspar
Uniform—Dependable

EACH SHIPMENT IS TESTED IN OUR OWN LABORATORY

MINERS AND GRINDERS OF CANADIAN SPAR SINCE 1902

Genesee Feldspar Company, Inc.

Successors to
Pennsylvania Feldspar Co.

ROCHESTER **NEW YORK**

Highlands Fire Clay Co.
Illinois Clay Products Co.
Illinois Kaolin Co.
International Ore & Smelting Co.
Kentucky Construction & Improvement Co.
Kier Fire Brick Co.
Laclede-Christy Clay Prod. Co.
Lindsay, Geo. W.
Louisville Fire Brick Co.
McHose, L. H. Co.
McLain Fire Brick Co.
Missouri Fire Brick Co.
Mitchell Clay Manufacturing Co.
Moon Clay & Kaolin Co.
Moroney, John J. & Co.
Morrison Clay & Coal Mines
New York and Pennsylvania Clay Prod. Co.
Ostrander Fire Brick Co.
Pegram Clay Co.
***Pennsylvania Pulverizing Co.**
Pfeiffer, C.
Potters Supply Co.
Pueblo Clay Products Co.
Remmey, Richard C., Son Co.
***Roessler & Hasslacher Chemical Co.**
Rue Clay Co.
***Sant, John & Sons Co.**
Sant, Thos. H. & Son Co.
Savage Mountain Fire Brick Co.
Savage Fire Brick Co.
Smith, A. F. Co., The
St. Louis Fire Brick & Clay Co.
Stevens, Inc.
Stockton Fire Brick Co.
Stowe Fuller Co.
United States Refractories Corp.
***United Clay Mines Corp.**
Valentine, M. D. & Bro.
Vermont Kaolin Corporation
Wellsville Fire Brick Co.
Whitehead Bros. Co.

FLUORITE

Atkins, Kroll & Co.
Foote Mineral Co., Inc.
Lavino, E. J. Co.
Salomon, L. A. & Son
Tennant, C. Sons & Co.

FLUORSPAR

Fairview Fluorspar Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Hickman, Williams & Co.
Hillside Fluorspar Mines
Industrial Minerals Corp.
Kentucky Construction & Improvement Co.
Kentucky Fluorspar Co.
Los Angeles Chemical Co.
National Sales Corp.
Ohio Valley Fluorspar Co.
Robins, G. S. Co.
***Roessler & Hasslacher Chemical Co.**
Rogers, Brown & Co.
Rosiclare Lead & Fluorspar Co.
Spar Mountain Mining Co.
Standard Fluorspar Co.
Wardrop & Son
Webber-Wood Spar Mining Co.

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* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

FRIT

***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co., The**
***Porcelain Enamel & Mfg. Co.**
Vitreous Enameling Co.
***Vitro Mfg. Co.**

FULLERS' EARTH

Farnsworth, R. N.

GANISTER

(Quartzite)

***General Refractories Co.**
Harbison-Walker Refractories Co.
International Silica Co.
Kier Fire Brick Co.
United States Refractories Corp.

GARNET

American Glue Co.
Barton, H. H. & Sons Co.
Foote Mineral Co., Inc.
North River Garnet Co.
Warren County Garnet Mills

GILSONITE

Mitchell-Rand Mfg. Co.

GLASS DECOLORIZERS

Drakenfeld, B. F. & Co.
Frink Decolorizer Co.
Owens Bottle Co.

GLASS

(Powdered)

Crystal Bldg. Products Corp.
***Ferro Enamel Supply Co., The**
Harshaw, Fuller & Goodwin Co.
***Porcelain Enamel & Mfg. Co.**
***Roessler & Hasslacher Chemical Co.**
Wiarda, John C. & Co.

GOLD and BRONZES

***Hanovia Chemical & Mfg. Co.**
Hasburg, John W. Co.
Hommel, O. Co.
***Roessler & Hasslacher Chemical Co.**

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

GRAIN
(Abrasive)

American Emery Wheel Works
Carborundum Co., The
Exolon Co., The
General Abrasive Co.
Jackson Mill Emery Co.
Norton Co.
Vitrified Wheel Co.
Waltham Grinding Wheel Co.

GRAPHITE

Joseph Dixon Crucible Co.
Pettinos Bros.
Super Flake Graphite Co.
U. S. Graphite Co.

GRAPHITE
(Natural and Artificial)

Acheson Graphite Co.
Atkins, Kroll & Co.
Dixon, Jos. Crucible Co.
Hooper Graphite Co.
Import Chemical Co.

GROSS ALMERODE CLAY

Goebel, J. & Co.

GYPSUM

Alabastine Company
American Gypsum Co.
Beaver Products Co.
Beaver Products Co., Inc.
Cardiff Gypsum Co.
Centerville Gypsum Co.
Ebsary Gypsum Co., Inc.
Empire Gypsum Co.
Lycoming Calcining Co.
Niagara Gypsum Co.
Oakfield Gypsum Products Co.
Pacific Coast Gypsum Co.
Phoenix Gypsum Co.
Salomon, L. A. & Son
United States Gypsum Co.
Universal Gypsum Co.
Wasem Plaster Co.

HALITE
(Rock Salt)

Cayuga Rock Salt Co., Inc.
Retsof Mining Co.
Sterling Salt Co.

HEMATITE

Clinton Metallic Paint Co.
Foote Mineral Co., Inc.
Fruitland Iron Ore Co.
Mississippi Iron Co.
Stanley Doggett, Inc.

Use this side of page for your memos.

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ILEMITE

American Rutile Co.
Buckman & Pritchard, Inc.
Foote Mineral Co., Inc.

IRON CHROMATE

Foote Mineral Co., Inc.
Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chemical Co.**

IRON OXIDE

Clinton Metallic Iron Ore Co.
Richard Coulston Co.
Drakenfeld, B. F. & Co.
Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chem. Co.**
Williams, C. K. Co.
Winters Metallic Paint Co.

IRON SILICATE

Finkell, Wm. Co.

KAOLIN

Albion Kaolin Co.
Butcher, L. H. Co., The
***Central of Georgia Ry.** (J. M. Mallory)
Cherokee Mining Co.
Cummings, J. W., Feldspar Co.
Dill Coppage, Inc.
Dixie Fireproofing Co.
Edgar Bros. Co.
Finney, Robert Spencer
Florida China Clay Co.
***Golding Sons Co.**
Hammill & Gillespie, Inc.
Harris Clay Co.
Harshaw, Fuller & Goodwin Co.
International Silica Co.
Immaculate Kaolin Co.
Laclede-Christy Clay Products Co.
Lake County Clay Co.
Maine Feldspar Co.
Moore & Munger
National Sales Corp.
Newark China Clay Co.
***Paper Makers Importing Co.**
Pacific Sanitary Mfg. Co.
Penland Feldspar & Kaolin Co.
***Roessler & Hasslacher Chemical Co.**
***Sant, John & Sons Co.**
Sant, Thos. H. & Son Co.
***United Clay Mines Corp.**
***Vanderbilt, R. T. Co.**
Vermont Kaolin Corp.

KAOLINITE

Foote Mineral Co., Inc.
Salomon, L. A. & Son

Use this side of page for your memos.

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MAINE FELDSPAR COMPANY

Grinders of
Mt. Apatite Spar

Mills
Auburn and Topsham, Maine

Main Office
Brunswick, Maine

Sale Agents
Charles M. Franzheim Co., Wheeling, W. Va.

To err is but human. No doubt there are mistakes between the covers of this book but we want your constructive criticism. It is only by such criticism that we can hope to make the next issue and succeeding issues of more value to you.

A work of this kind is never finished and as we go to press we are receiving notices of deposits and concerns dealing in ceramic materials. To include them would only delay this issue. If what you want is not listed, write us and we'll try to help you out.

Advertising Department, American Ceramic Society.
Lord Hall, O.S.U. **Columbus, Ohio.**

Use this side of page for your memos.

KIESELGUHR
(See Diatomaceous Earth)

KRYOLITH
Pennsylvania Salt Mfg. Co.

LEAD
(Red)
Butcher, L. H. Co.
Eagle Picher Lead Co.
National Lead Co.
National Lead & Oil Co.
*Roessler & Hasslacher Chemical Co.

LEAD
(White)
Eagle Picher Lead Co.
Lewis, John T. Bro.
National Lead Co.
National Lead & Oil Co.
*Roessler & Hasslacher Chemical Co.

LEAD CHROMATE
Butcher, L. H. Co.
Fuller, W. P. Co.
Los Angeles Chemical Co.
Harshaw, Fuller & Goodwin Co.
Richard, H. N. Co.
*Roessler & Hasslacher Chemical Co.

LEAD OXIDE
Fuller, W. P. Co.
Harshaw, Fuller & Goodwin Co.
Wetherill Bros.

LENKONIN
Harshaw, Fuller & Goodwin Co.
*Roessler & Hasslacher Chemical Co.

LEPIDOLITE
Drakenfeld, B. F. & Co.
Foote Mineral Co., Inc.
National Sales Corp.

LIME—LIMESTONE
(Hydrated Lime)
Consumers Co.
Consumers Lime Co.
Herzog, John & Son
Kelly Island Lime & Transport Co.
Louisville Cement Co.
National Mortar & Supply Co.
Standard Lime & Stone Co.
Washington Brick Lime & Sewer Pipe Co.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

LIONITE
(Aluminous Abrasive)
General Abrasive Co., Inc.

LITHARGE
Eagle Picher Lead Co.
Evans Lead Co.
Harshaw, Fuller & Goodwin Co.
National Lead Co.
***Roessler & Hasslacher Chemical Co.**

LITHIUM CARBONATE
***Roessler & Hasslacher Chemical Co.**

MAGNESITE
Atkins, Kroll & Co.
Foote Mineral Co.
General Magnesite & Magnesia Co.
***General Refractories Co.**
Hammill & Gillespie, Inc.
Harbison-Walker Refractories Co.
Import Chemical Co.
Lavino, E. J. Co.
National Sales Corp.
Northwest Magnesite Co.
Salomon, L. A. & Son
Scottish Canadian Magnesite Co.
Tennant, C. & Sons Co.

MAGNESIUM CARBONATE
Harshaw, Fuller & Goodwin Co.
Keasbey & Mattison Co.
***Roessler & Hasslacher Chemical Co.**
Van Schaack, Peter & Son

MAGNESIUM FLUORIDE
National Sales Corp.

MAGNESIUM OXIDE
General Magnesite & Magnesia Co.
***General Refractories Co.**
Maltby, C. S.

MAGNETITE
Chateaugay Ore & Iron Co.
Foote Mineral Co., Inc.
Fort Montgomery Iron Corp.
Port Henry Iron Ore Co.
Witherbee, Sherman & Co.

MANGANESE
Hy-Grade Manganese Co.
Lavino, E. J. Co.

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MANGANESE DIOXIDE

Baker, J. T. Chemical Co.
Butcher, L. H. Co.
Drakenfeld, B. F. & Co.
***Ferro Enamel Supply Co., The**
Ferro Manganese Co.
Harshaw, Fuller & Goodwin Co.
Hy-Grade Manganese Co.
Lavino, E. J. Co.
Robins, G. S. Co.
***Roessler & Hasslacher Chemical Co.**
***Vitro Mfg. Co.**
Wiarda, John C. & Co.

MARBLE DUST

Hammill & Gillespie, Inc.
Patek Bros., Inc.

MODELING CLAY

Denver Fire Clay Co.
Laclede-Christy Clay Products Co.
Lewis Institute
Pewabic Pottery

MONAZITE

Buckman & Pritchard, Inc.
Foote Mineral Co., Inc.

NICKEL OXIDE

Braun Corp.
Drakenfeld, B. F. & Co.
***Ferro Enamel Supply Co., The**
Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chemical Co.**

OAKITE

Oakley Chemical Co.

OCHRES

Dill Coppage
Drakenfeld, B. F. Co.
Harshaw, Fuller & Goodwin Co.
International Silica Co.
Patek Bros., Inc.
***Roessler & Hasslacher Chemical Co.**
Vermont Kaolin Corp.

OPACIFIERS

***Titanium Alloy Mfg. Co.**
***Vitro Manufacturing Co.**

Use this side of page for your memos

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ORTHOCLASE
Foote Mineral Co., Inc.

PARIS WHITE
*Franzheim, Chas. M. Co.
Hammill & Gillespie, Inc.
Potters Supply Co.
*Roessler & Hasslacher Chemical Co.
Taintor, H. F. & Co.

PHILOGOPITE
Foote Mineral Co., Inc.

PLASTER OF PARIS
Beaver Products Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Nephi Plaster & Mfg. Co.
*Roessler & Hasslacher Chemical Co.
U. S. Gypsum Co.
*Vanderbilt, R. T. Co.

POT CLAYS
*General Refractories Co.
Harbison-Walker Refractories Co.
Harshaw, Fuller & Goodwin Co.
Hickory Ball Clay Co.
Johnson-Porter Clay Co.
Laclede-Christy Clay Prod. Co.
Mitchell Clay Mfg. Co.
Pittsburgh Plate Glass Co.
*Sant, The John & Sons Co.
Sant, Thos. H. & Son Co.
*United Clay Mines Co.

POTASSIUM CARBONATE
Harshaw, Fuller & Goodwin Co.
Innis, Speiden Co.
*Roessler & Hasslacher Chemical Co.

POTASSIUM CHROMATE
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
*Roessler & Hasslacher Chemical Co.

POTASSIUM NITRATE
Batelle & Renwick
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
*Roessler & Hasslacher Chemical Co.

Use this side of page for your memos.

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Iron Oxide

(Fe_2O_3)

Under 0.025%

Guaranteed

A purity secured by **processing,** through special equipment, such as is used by no other sand producer.

Mesh Size Guarantee:

That 98% will rest on a 70 mesh screen—No dust.
That 100% will pass thru a 28 mesh screen—No oversize grains.

No other sand producer, up to this writing, has attempted to offer **any** mesh guarantee whatsoever.

What These Guarantees Mean

Low Iron Oxide means clear, beautiful, glass products which should command a premium in every market. **Evenmelt-made glass** has a **natural** life and sparkle because the purity of this sand reduces to the minimum the use of deadening decolorizers.

Uniformity in Mesh-Size reduces melting-time and fuel-cost. The absence of both dust and oversize grains also enables the melter to secure a homogeneous, quiet, fluid metal that produces a glass which is remarkably free from cords, stones or other defects.

Both the above virtues of **EVENMELT** will enable you to cut down your present percentage of spoiled and unsalable goods.

When you use EVENMELT Glass Sand you make more glass and less cullet; more money, with less worry.

Year-Round Service

We operate every day in the year, no matter what the extremes in temperature; so can guarantee the loading of all requirements.

Let us ship you a sufficient tonnage for a thorough working test, you to pay the freight from Ottawa, Illinois; and to pay us for the **sand, your** estimate of its value to you, compared with the current market price on **unprocessed** sand.

UNITED STATES SILICA CO.
122 South Michigan Ave. Chicago

PYRITES
(Iron)

Foote Mineral Co., Inc.
New York Zinc Co., Inc.
Pennsylvania Salt Mfg. Co.

PYROLUSITE

Atkins, Kroll & Co.
Bedford Mining Co.
Eureka Flint & Spar Co.
Foote Mineral Co., Inc.
*Genesee Feldspar Co.
Import Chemical Co.
Innis, Speiden Co.
Lavino, E. J. Co.
Michigan Quartz Silica Co.
National Sales Corp.
*National Silica Co.
N. Y. Pyrites Co., Inc.
Ottawa Silica Co.
Product Sales Co.
Wedron Silica Co.

QUARTZ
(Fused Ware)

Thermal Syndicate, Ltd.

QUARTZ
(Silica Sand)

American Manganese Co.
Berkeley Glass Sand Co.
Central Silica Co.
Crossman Co.
Deckers Creek Sand & Stone Co.
Harshaw, Fuller & Goodwin Co.
Hazel-Atlas Glass Co.
Kramer Bros.
Lindsay, Geo. W.
Maryland Quartz Co.
Michigan Silica Co.
*National Silica Co.
Ottawa Silica Sand Co.
Pennsylvania Glass Sand Co.
Pittsburgh Sand Co.
*Roessler & Hasslacher Chemical Co.
Silica Products Co.
Speers Sand Co.
*U. S. Silica Co.
Wiarda, John C. & Co.

QUARTZ and FLINT

American Encaustic Tiling Co.
American Grinding Co.
Cheshire White Quartz Sand Co.
Clinch Mountain Silica Sand Co.
Eureka Flint & Spar Co.
*Franzheim, Chas. M. Co.
General Basic Prod. Co.
*General Refractories Co.
*Golding Sons' Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.

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Howe, L. W. S.
Industrial Minerals Corp.
International Silica Co.
Isco-Bautz Co., Inc.
Los Angeles Chemical Co.
Maryland Quartz Co.
Manufacturers Mineral Co.
***National Silica Co., The**
National Silica Works
New England Quartz Co.
New Jersey Pulverizing Co.
O'Brien & Fowler
Ohio Silica Co.
Ottawa Silica Co.
Penland Feldspar & Kaolin Co.
***Pennsylvania Pulverizing Co.**
Pennsylvania Quartz Co.
Potters Mining & Milling Co.
Potters Supply Co.
***Roessler & Hasslacher Chemical Co.**
Seaboard Feldspar Co.
Southern Minerals Corp.
Sullivan, A. H.
Tamms Silica Co.
Trenton Flint & Spar Co.
***U. S. Silica Co.**
Wiarda, John C. & Co.

RETORT CLAYS

***General Refractories Co.**
McHose, L. H.
National Sales Corp.
***Paper Makers Importing Co.**
***United Clay Mines Corp.**

RHODOCROSITE

Import Chemical Co.

RUTILE

American Encaustic Tiling Co.
American Rutile Co.
Buckman & Pritchard, Inc.
Drakenfeld, B. F. & Co.
Foote Mineral Co., Inc.
Harshaw, Fuller & Goodwin Co.
Metal & Thermit Corp.
National Sales Corp.
***Roessler & Hasslacher Chemical Co.**
***Titanium Alloy Mfg. Co.**

SAGGER CLAYS

Alberhill Coal & Clay Co.
Anness & Potter Fire Clay Co.
Bacon, M. J.
Brinkman, S. G.
Butler, E. L. Clay Co.
Colonial Clay Co.
Cooley Clay Co.
Crossman Co.
Dilts Brothers
Edgar Bros. Co.
Enterprise White Clay Co.
Excelsior Ball Clay Co.
Fair Valley Clay Co.
***Franzheim, Chas. M. Co.**

Use this side of page for your memos.

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Frost, S.
*Golding Sons Co., Inc.
Goodwin Supply Co.
Hammill & Gillespie, Inc.
Hampton Cutter Co.
Harris Clay Co.
Hickory Ball Clay Co.
Illinois Kaolin Co.
Johnson-Porter Clay Co.
Kentucky Clay Mining Co.
Kentucky Construction & Improvement Co.
Laclede-Christy Clay Products Co.
Ladd, F. E.
Lincoln Clay Products Co.
Mandle Clay Mining Co.
Moon Clay & Kaolin Co.
Morgan & Horton Clay Co.
Morrison Clay & Coal Mines
Morton, J. F., Inc.
National Sales Corporation
Old Hickory Clay & Tile Co.
*Paper Makers Importing Co.
Paducah, Clay Co.
Potters Supply Co.
Product Sales Co.
Ryan, P. L. Estate of
*Sant, John & Sons Co.
Sant, Thos. H. & Son Co.
Such Clay Co.
Tamms Silica Co.
*United Clay Mines Corp.
Union Clay Products Co.
*Vanderbilt, R. T. Co.
West Side Coal Co.

SAL SODA

Soda (See Sodium Carbonate)

SALT CAKE

General Chemical Co.
Grasselli Chemical Co.
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
*Roessler & Hasslacher Chem. Co.

SAND

Crescent Silica Co.
National Silica Co.
*U. S. Silica Co.

SAND

(Fire)

Birish, S.
Bloomfield Clay Co.
Denver Fire Clay Co.

(See also Silicon Carbide)

SAND

(Placing)

*Pennsylvania Pulverizing Co.
*United Clay Mines Corp.

Use this side of page for your memos.

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Uniformity of Products

The Chas. M. Franzheim Co.

Wheeling, W. Va.

New York Office—345 Madison Ave.

CHINA AND BALL CLAYS
—N. C. CHINA CLAY—
FELDSPAR—FLINT
GENUINE PARIS WHITE
CORNWALL STONE
BITSTONE

MINES AND MILLS:

TOPSHAM, MAINE
AUBURN, MAINE
BALTIMORE, MD.
SOUTH AMBOY, N. J.
STAMFORD, CONN.
BERKELEY SPRINGS, W. VA.
CORNWALL ENGLAND
DEVON, ENGLAND
DORSET, ENGLAND
SPRUCE PINE, N. C.

SCHEELITE

Atkins, Kroll & Co.

SELENIUM

Baker, J. T. Chemical Co.
Drakenfeld, B. F. & Co.
Foote Mineral Co., Inc.
Harshaw, Fuller & Goodwin Co.
Import Chemical Co.
National Sales Co.
***Roessler & Hasslacher Chemical Co.**
Tennant, C. Sons & Co.

SIDERITE

Morehead, J. H.
Pennsylvania Salt Mfg. Co.

SILEX

Atkins, Kroll & Co.
International Silica Co.
National Sales Corp.
Salomon, L. A. Sons

SILICA
(Amorphous)

International Silica Co.
National Sales Corp.
Pacific Sanitary Mfg. Co.

SILICA
(Fused Ware)

Thermal Syndicate, Ltd.

SILICON CARBIDE

Carborundum Co., The
Exolon Co., The
Norton Co.

SILLIMANITE

Champion Sillimanite Corp.
Foote Mineral Co., Inc.

SLIP CLAY
(Albany)

Albany Slip Clay Co.
Consolidated Slip Clay Co.
Empire Clay Mining Co.
Jackson, J. H. Tile Co., Inc.

Use this side of page for your memos.

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SLIP CLAYS

Consolidated Slip Clay Corp.
Empire Clay Mining Co.
Jackson, John H., Tile Co.
Robinson Clay Products Co.

SOAPSTONE

(See Talc)

SODA

(Sodium Carbonate)

Diamond Alkali Co.
Harshaw, Fuller & Goodwin Co.
Mallinckrodt Chemical Works
Michigan Alkali Co.
Pennsylvania Salt Mfg. Co.
***Roessler & Hasslacher Chemical Co.**
Van Schaack, Peter & Son
Wiarda, John C. & Co.
Wing & Evans, Inc.

SODA ASH

Diamond Alkali Co.
Du Pont Chemical Works
Ford, J. B. Co.
George, W. F. Chemicals Co.
Grasselli Chemical Co.
Harshaw, Fuller & Goodwin Co.
Hooker Electrochemical Co.
Los Angeles Chemical Co.
Maryland Chemical Co.
Mathieson Alkali Works, Inc.
Michigan Alkali Co.
Pennsylvania Salt Mfg. Co.
Robins, G. S. Co.
***Roessler & Hasslacher Chemical Co.**
Scobell Chem. Co.
Solvay Process Co.
Wing & Evans, Inc.

SODIUM ALUMINATE

Pennsylvania Salt Mfg. Co.

SODIUM ANTIMONATE

Metal & Thermit Corp.
***Roessler & Hasslacher Chemical Co.**

SODIUM CARBONATE

(See Soda)

SODIUM FLUORIDE

Baker, J. T. Chemical Co.
Foote Mineral Co., Inc.
***Roessler & Hasslacher Chemical Co.**
Tennant, C. Sons & Co.
Wiarda, John C. & Co.

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SODIUM NITRATE

Adler, W. R. Co.
Baugh Chemical Co.
Grace, W. R.
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
Lynn, Wm. & Co.
***Roessler & Hasslacher Chemical Co.**
San Francisco Salt Refining Co.
Stauffer Chemical Co.
Western Wholesale Drug Co.
Wiarda, John C. & Co.

SODIUM PHOSPHATES

Foote Mineral Co., Inc.
Tennant C. Sons & Co.

SODIUM SELENITE

Drakenfeld, B. F. & Co.

SODIUM SILICATE

Baker, J. T. Chemical Co.
Croxall Chemical Co.
Grasselli Chemical Co.
Harshaw, Fuller & Goodwin Co.
Philadelphia Quartz Co.
Richards, H. N. Co.
***Roessler & Hasslacher Chemical Co.**
Tennant, C. Sons & Co.

SODIUM URANATE

Drakenfeld, B. F. & Co.

SPODUMENE

Foote Mineral Co., Inc.

STEATITE

American Lava Corp.

STIBNITE

Foote Mineral Co., Inc.
Import Chemical Co.

STONEWARE CLAYS

Edgar Bros. Co.
Pirrine, H. C. & Son
Smith, A. F. Co.
South River Clay Co.
***United Clay Mines Corp.**

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STRONTIANITE

Foote Mineral Co., Inc.
Veenvliet, R.

SULPHUR

Drakenfeld, B. F. & Co.
Harshaw, Fuller & Goodwin Co.
Kelly, G. A. Co.
*Roessler & Hasslacher Chemical Co.

TALC

(Soapstone)

Atkins, Kroll & Co.
Carbola Chemical Co., Inc.
Eastern Magnesia Talc Co.
Foote Mineral Co., Inc.
Gillespie, Geo. H. Co., Ltd.
Inyo Talc Co.
International Talc Co.
International Pulp Co.
Loomis, W. H. Talc Corp.
National Sales Corp.
Product Sales Co.
Salomon, L. A. Sons
Tennant, C. Sons & Co.
Williams, C. K.

TALC

(Steatite, Soapstone)

American Lava Corp.
Barrett, M. L. Co.
Eastern Magnesia Talc Co.
Gillespie, G. H. & Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Inyo Talc Co.
Los Angeles Chemical Co.
Master Products Co.
National Sales Corp.
*Roessler & Hasslacher Chemical Co.

THERMALIN

Metal & Thermit Corp.

THORITE

Foote Mineral Co., Inc.

THORIUM OXIDE

Welsbach Co.

TIN OXIDE

Butcher, L. H. Co.
Drakenfeld, B. F. & Co.
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
Metal & Thermit Corp.
*Roessler & Hasslacher Chemical Co.

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TOPAZ
Foote Mineral Co., Inc.

TREMOLITE
Metronite Company

TRIPOLITE
Garrard & Haynes
Salomon, L. A. Sons

UMBER
Butcher, L. H. Co.
Coulston, Richard, Inc.
***Roessler & Hasslacher Chemical Co.**

URANIUM OXIDE
Drakenfeld, B. F. & Co.
Foote Mineral Co.
Harshaw, Fuller & Goodwin Co.
***Roessler & Hasslacher Chemical Co.**

VALLENDER CLAY
Hammill & Gillespie, Inc.

WAD CLAYS
Brinkman, S. G.
Enterprise White Clay Co.
Erato, R. R.
Harshaw, Fuller & Goodwin Co.
Illinois Kaolin Co.
Johnson-Porter Clay Co.
Kentucky Clay Mining Co.
Kentucky Construction & Improvement Co.
Mandle Clay Mining Co.
Morton Clay Co.
National Sales Corp.
Paducah Clay Co.
***Paper Makers Importing Co.**
Potters Supply Co.
***Sant, John & Sons Co.**
Sant, Thos. H. & Son Co.
Spinks, H. C. Clay Co.
***United Clay Mines Corp.**

Use this side of page for your memos.

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Commercial Zirconium Oxide. A practical Enamel and Glass Material giving Opacity Plus.

Zirconium Silicate, Refined. Granular or milled. Adds refractoriness and decreases expansion of Bodies, Glazes, and Enamels. Milled with Ground Coat Enamel — Increases adhesion and broadens Safe Firing Temperature range.

Zirconium Oxide Electrically Fused. 95% Zirconium Oxide. A Super-Refractory Material for High Insulation and High Temperature Values.

94% Titanium Oxide. Granular or Milled. A specially prepared product for Glass, Terra Cotta, and Faience. Adds acid resistance to Enamels.

The Titanium Alloy Manufacturing Co.

Ceramic Materials Department

R. D. Landrum, General Manager

6007 Euclid Ave. : : : : : : Cleveland, Ohio

WHITING

Columbia Products Co.
Croxall Chemical Co.
Daigger, A. & Co.
***Franzheim, Chas. M. Co.**
Fuller, W. P. & Co.
Hammill & Gillespie, Inc.
Hanna Paint Co.
Harshaw, Fuller & Goodwin Co.
Donald A. Holm Co.
International Products Co.
Kauffman-Lattimer Co.
McGrory, R. F. Co.
Muirhead, A. & Co.
National Sales Co.
Potters Supply Co.
Product Sales Co.
Richards, H. N. Co.
***Roessler & Hasslacher Chemical Co.**
Southwark Mfg. Co.
Taintor Co., The
Tamms Silica Co.
Weightman-Thompson Co.
Wishnick-Tumpeer Co.

WITHERITE

Foote Mineral Co., Inc.
Lavino, E. J. Co.
National Sales Corp.

ZINC OXIDE

American Metal Co.
Daigger, A. & Co.
Drakenfeld, B. F. & Co.
Eagle Picher Lead Co.
Grasselli Chemical Co.
Hammill & Gillespie, Inc.
Harshaw, Fuller & Goodwin Co.
Los Angeles Chemical Co.
Metal & Thermit Corp.
Mifford Chemical Co.
Mineral Point Zinc Co.
New Jersey Zinc Sales Co.
Patek Bros., Inc.
Richards, H. N. Co.
Robins, G. S. Co.
***Roessler & Hasslacher Chemical Co.**

ZIRCON

Buckman & Pritchard, Inc.
***Titanium Alloy Mfg. Co.**
***Vitro Mfg. Co.**

ZIRCONIUM OXIDE

Foote Mineral Co.
***Roessler & Hasslacher Chemical Co.**
***Titanium Alloy Mfg. Co.**
Welsbach Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Supplies and Equipment

ACCELERATORS
Manufacturers Equipment Co.

AGITATORS
*Crossley Machine Co., The
International Clay Machinery Co.
*Mueller Machine Co.

AIR BRUSHES
*Chicago Vitreous Enamel Product Co.
DeVilbiss Mfg. Co.
Hommel, O. Co.
*Porcelain Enamel & Mfg Co.

AIR COMPRESSORS
*Ferro Enamel Supply Co., The
General Electric Co.
Ingersoll-Rand Co.

ANALYSES
(Clay)

Harrop, Carl B.
Louis G. Robinson
Sharp-Schurtz Co.
Wilkins, W. W.

ATOMIZERS
*Chicago Vitreous Enamel Product Co.
DeVilbiss Mfg. Co.
*Ferro Enamel Supply Co., The

AUGER MACHINES
Chambers Brothers Co.
Freese, E. M. & Co.
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
Lancaster Iron Works
Manufacturers Equipment Co.
*Porcelain Enamel & Mfg. Co.
Steele, J. C. & Sons

AUTOMATIC CUTTERS
Chambers Brothers Co.
Freese, E. M. & Co.
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
Manufacturers Equipment Co.

AUTOMATIC STOVE ROOMS
Philadelphia Drying Machinery Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY

AUTOMATIC TEMPERATURE CONTROL

Brown Instrument Co.
Engelhard, Chas. Inc.
Leeds & Northrup Co.
Taylor Instrument Co.
Wilson-Maeulen Co.

BATTS

(Refractory)

Norton Company

BELT LACING

Clipper Belt Lacer Co.

BELTING

(Canvas, Steel, Rubber, Wire)

American Wire Fabrics Corp.
Gandy Belting Co., The
Goodyear Tire & Rubber Co., The
Imperial Belting Co.
Main Belting Co.
Quaker City Rubber Co.
Sandvik Steel, Inc.

BLOCKS

(Refractory, Glass Tank, Insulating)

Armstrong Cork & Insulation Co.
Buckeye Clay Pot Co.
Carr-Lowrey Glass Co.
***General Refractories Co.**
Norton Company
Pittsburgh Plate Glass Co.
Russell Engineering Co.

BLOWERS

American Blower Co.
Buffalo Forge Co.
Connersville Blower Co.
Denver Fire Clay Co.
Monarch Engineering Co., The

BLUNGERS

Cain Machine Co.
***Ceramic Machinery Co.**
***Crossley Machine Co., The**
International Clay Machinery Co.
***Mueller Machine Co.**
Stoll, G. C.

BOILERS

(Steam)

Babcock & Wilcox Co.
***Crossley Machine Co., The**
Erie City Boiler Works

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

The Ceramic Machinery Company
Hamilton, Ohio

Manufacturers of:

Blunger Mills
Slip Pumps
Filter Presses
Dust Mills
Crushers
Sagger Presses
Full Automatic Tile Presses
Semi-Automatic Tile Presses
Automatic Dusting and Glazing Machines
Automatic Measuring Machines
Tunnel Kiln Truck Propellers.
(Mechanical and Hydraulic)
Machine Tools.

Miscellaneous Equipment:

The only company that can furnish *complete modern mechanical equipment* for architectural tile factories.

Write for particulars

"ALUMITE"
Means—

LOWER COST—

—Because "Alumite" Refractories have a high alumina content, thus counteracting the fluxing action.

—Because the heat resistant or refractory quality allows for a high factor of safety.

—Because the heat conductivity is second only to Silicon Carbide. This is very necessary in enamel muffles, glass lehrs or recuperators.

BETTER WARE—

—Because they are uniform in size, thus avoiding leaks or combustion, gases in enamel muffles, or air leaks in walls of glass furnaces or pottery kilns.

Bulletins Nos. 19 and 20 explain the full line of "Alumite" refractories. There is one for every use. Our engineers will be glad to consult with you.

The Massillon Refractories Co.
MASSILLON, OHIO

Use this side of page for your memos.

BOXES
(See Corrugated Shipping Boxes)

BRICK
Fire (See also Refractories)

Chicago Retort and Fire Brick Co.
Denver Fire Clay Co.
Electrical Refractories Co.
***General Refractories Co.**
Laclede-Christy Clay Products Co.
***Massillon Refractories Co.**
Massillon Stove & Fire Brick Co.
Norton Company
Queen's Run Refractories Co.
Reading Fire Brick Works
Taylor, Chas. Sons Co.
U. G. I. Contracting Co.
Valentine, M. D. & Bro. Co.
Washington Brick, Lime & Sewer Pipe Co.

BRICK MACHINES AND CUTTERS

Anderson Foundry & Machine Co.
***Crossley Machine Co.**
Freese, E. M. & Co.
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co.
Manufacturers Equipment Co.
***Mueller Machine Co.**
Steele, J. C. & Sons

BRUSHES

***Ferro Enamel Supply Co., The**

BURNERS
(Oil)

Amsler-Morton Co.
Anthony Co., The
W. N. Best Corp.
Combustion Engineering Co.
Denver Fire Clay Co.
Geist Manufacturing Co.
Gilbert & Barker Mfg. Co.
Hagan, Geo. J. Co.
Harrop, Carl B.
Macleod Company, The
Maxon Premix Burner Co.
National Supply Co.
Russell Engineering Co.
Schurs Oil Burner Co.
Smokeless Oil Burner Co.
Tate-Jones Company

CALCINERS
(Rotary)

Christie Co., L. R.
Surface Combustion Co.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

CARS

(Drier)

*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
Manufacturers Equipment Co.

(Mine, Pit, Transfer)

Eagle Iron Works
International Clay Machinery Co.
Manufacturers Equipment Co.

(Wheels)

Eagle Iron Works
International Clay Machinery Co.
Watt Mining Car Wheel Co.

CASTINGS

(Grey Iron)

Eagle Iron Works

CERAMIC PLANT EQUIPMENT AND DESIGN

Ceramic Engineering Co.
Chambers Brothers Co.
*Crossley Machine Co.
*Ferguson, H. K. Co.
Manufacturers Equipment Co.
*Mueller Machine Co.
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

CEMENTS

(Refractory and High Temperature)

Celite Products Co.
Green, A. P. Fire Brick Co.
*General Refractories Co.
Harbison-Walker Refractories Co.
Laclede-Christy Clay Products Co.
Lavino, E. J. Co.
*Massillon Refractories Co.
Norton Company
U. G. I. Contracting Co.

CHAIN DRIVES

Link-Belt Co.
Morse Chain Co.

CLASSIFIERS

Dorr Company, The

CLAY WASHING MACHINERY

*Crossley Machine Co.
Dorr Company, The
*Mueller Machine Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

CLAY WORKING MACHINERY
(General)

*Ceramic Machinery Co.
*Crossley Machine Co.
*Hadfield-Penfield Steel Co.
Harrop, Carl B.
International Clay Machinery Co.
Lancaster Iron Works
Manufacturers Equipment Co.
*Mueller Machine Co.
Patterson Foundry & Machine Co.
Steele, J. C. & Sons
Stoll, G. C.

CLOTH
(Wire)

*Newark Wire Cloth Co.
Tyler, W. S. Co.

COLORS AND OXIDES
(See Raw Material and Chemical Section)

CONDITIONING MACHINERY

Carrier Engineering Co.
Philadelphia Drying Machine Co.
Proctor & Schwartz, Inc.

CONES
(Pyrometric)

Denver Fire Clay Co.
*Ferro Enamel Supply Co., The
Standard Pyrometric Cone Co.

CONSTRUCTION
(Plant)

Austin Co., The
*Ferguson, H. K. Co.
Harrop, Carl B.
Richardson, W. D.
Russell Engineering Co.
Tefft, C. Forrest

CONTROLLERS

Brown Instrument Co.
General Electric Co.
Leeds & Northrup Co.
Taylor Instrument Companies
Wilson-Maeulen Co.

CONVEYORS
(Brick, Clay, Coal, Tile, Etc.)

*Crossley Machine Co.
*Ferro Enamel Supply Co., The
Gandy Belting Co.
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
Jeffrey Manufacturing Co.
Link-Belt Co.
*Mueller Machine Co.
Philadelphia Drying Machinery Co.
Russell Engineering Co.
Sandvik Steel, Inc.

Use this side of page for your memos.

CORRUGATED SHIPPING BOXES
Hinde & Dauch Paper Co., The

COUNTERS
(Revolution)
Veeder Mfg. Co.

CRANES
(Overhead, Electric, Bucket, Etc.)
Cleveland Electric Tramrail Division
Link-Belt Company

CRUSHERS
(Laboratory)
Denver Fire Clay Co., The
(Plant)
American Pulverizing Co.
***Ceramic Machinery Co.**
Chambers Brothers Co.
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
Hardinge Co.
International Clay Machinery Co.
***Mueller Machine Co.**
Manufacturers Equipment Co.

CUTTING TABLES
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co.

DECOLORIZERS
(Glass)
Frink Decolorizer Co.
Innis, Speiden Co.
***Vitro Mfg. Co.**

DIES AND MOLDS
***Crossley Machine Co.**
***Mueller Machine Co.**
Toledo Mould Co., The
Zanesville Mould Co.

DIGGING EQUIPMENT
Eagle Iron Works
Industrial Works
Marion Shovel Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

MANSFIELD PRODUCTS ARE ROLLED FROM BOTTOM-POURED INGOTS

WABIK METAL

for

VITREOUS ENAMELING

Specially Adapted For

Stove Door Panels

Splasher Backs

Broiler-Pans

Table Tops

Refrigerators

and other flat work

SHEET BARS

INGOTS

MANSFIELD
SHEET AND TIN PLATE COMPANY

Mansfield, Ohio

MANSFIELD PRODUCTS ARE ROLLED FROM BOTTOM-POURED INGOTS

DISINTEGRATORS

Chambers Brothers Co.
*Crossley Machine Co.
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
*Mueller Machine Co.
Patterson Foundry and Machine Co.

DRAFT GAGES

Brown Instrument Co.

DRIERS

(Direct, Indirect, Steam, Waste Heat)

Carrier Engineering Co.
Ceramic Engineering Co.
*Ceramic Machinery Co.
*Crossley Machine Co.
*Ferro Enamel Supply Co., The
International Clay Machinery Co.
Manufacturers Equipment Co.
Philadelphia Drying Machinery Co.
*Porcelain Enamel & Mfg. Co.
Proctor & Schwartz, Inc.
Surface Combustion Co.

(Rotary)

Christie, L. R. Co.

(Waste Heat, Radiated Heat, Direct Fired)

Harrop, Carl B.
Manufacturers Equipment Co.
Russell Engineering Co.

DRYING MACHINERY

Carrier Engineering Co.
International Clay Machinery Co.
Manufacturers Equipment Co.
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

DRY PANS

Chambers Brothers Co.
Clearfield Machine Co.
*Crossley Machine Co.
Eagle Iron Works
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.

DUST COLLECTORS

Macleod Company, The

ELECTRIC HEATING ELEMENTS

American Resistor Co.
Driver-Harris Co.
General Electric Co.
Hoskins Mfg. Co.

Use this side of page for your memos.

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ELECTRICAL INSTRUMENTS

Brown Instrument Co.
Engelhard, Chas. Inc.
Leeds & Northrup Co.
Republic Flow Meters Co.
Wilson-Maeulen Co.

ELEVATORS

Jeffrey Manufacturing Co.
Link-Belt Company
Manufacturers Equipment Co.

ENAMEL IRON

***American Rolling Mill Co.**
***Mansfield Sheet & Tin Plate Co.**
United Alloy Steel Corp.

ENAMEL SPRAYING EQUIPMENT

***Chicago Vitreous Enamel Product Co.**
***Porcelain Enamel Mfg. Co.**

ENAMELING EQUIPMENT
(Complete)

***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co., The**
***Porcelain Enamel & Mfg. Co.**
Proctor & Schwartz, Inc.

ENAMELING FURNACES
(See also Furnaces)

Carborundum Co.
***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co., The**
General Electric Co.
Hagan, Geo. J. Co.
Holcroft & Company
Norton Company
Parker-Russell Mining & Mfg. Co.
***Porcelain Enamel & Mfg. Co.**
Surface Combustion Co.
U. S. Smelting Furnace Co.
***Vitro Manufacturing Co.**

ENAMELING MUFFLES

Carborundum Company
General Electric Co.
Norton Co.
Parker-Russell Mining & Mfg. Co.

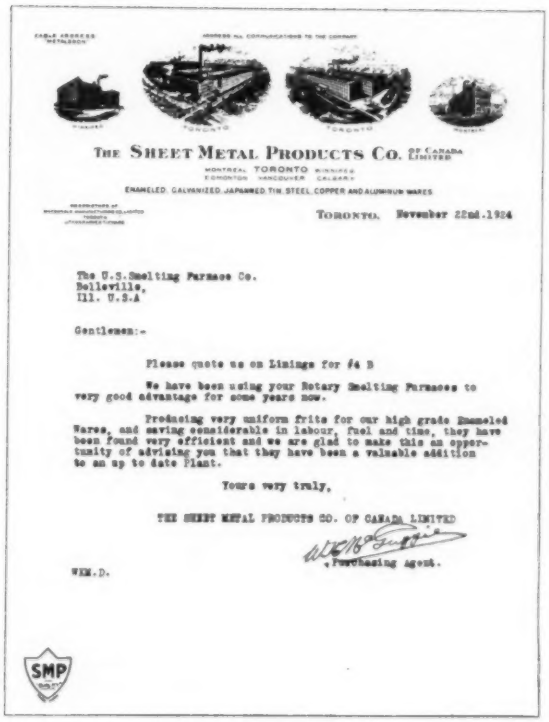
ENGINEERING SERVICE

Amsler-Morton Co.
Austin Co.
Carborundum Co.
Ceramic Engineering Co.
***Chicago Vitreous Enamel Product Co.**
***Ferguson, H. K. Co.**
Harrop, Carl B.
International Clay Machinery Co.
Karl Langenbeck
Manufacturers Equipment Co.
Miller Glass Engineering Co.
***Porcelain Enamel & Mfg. Co.**
Richardson, W. D.
Robinson, Louis G.
Russell Engineering Co.
Surface Combustion Co.
Sharp-Schurtz Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

LARGE CANADIAN ENAMELING PLANT USING BATTERY OF U. S. ROTARY ENAMEL SMELTING FURNACES



THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED

MONTREAL TORONTO WINNIPEG EDMONTON VANCOUVER CALGARY

ENAMELED, GALVANIZED, JAPANNED TIN, STEEL, COPPER AND ALUMINUM WARES

TORONTO, November 22nd.1924

The U.S.Smelting Furnace Co.
Belleville,
Ill. U.S.A

Gentlemen:-

Please quote us on Linings for #4 B

We have been using your Rotary Smelting Furnaces to very good advantage for some years now.

Producing very uniform frits for our high grade Enameled Wares, and saving considerable in labour, fuel and time, they have been found very efficient and we are glad to make this an opportunity of advising you that they have been a valuable addition to an up to date Plant.

Yours very truly,

THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED

Purchasing Agent.

WEM.D.

SMP

Years of Efficient Service

Very Uniform Frits at a Saving in Fuel, Labor and Time

A Valuable Addition

SIZES AND CAPACITIES

No. 1	No. 2	No. 3	No. 4	No. 4-B
60 lb.	150 lb.	350 lb.	750 lb.	1200 lb.

Description, Photographs, Specifications and Prices Mailed Promptly.

THE U. S. SMELTING FURNACE CO.

BELLEVILLE, ILLINOIS, U. S. A.

EXTRUDING MACHINES
Chambers Brothers Co.
International Clay Machinery Co.

EYE PROTECTORS
*Ferro Enamel Supply Co., The
Willson Goggles, Inc.

FANS
(Forced, Induced, Portable, Exhaust)
American Blower Co.
Connersville Blower Co.
*Ferro Enamel Supply Co., The
Monarch Engineering Co.

FILTER CLOTH AND SACKS
(Cloth—Metal)
National Sales Corp.
*Newark Wire Cloth Co.
Stanley, W. W.
Tyler, W. S. Co.

FILTER PRESSES (See Presses)

FIRE BRICK (See Brick, Fire)

FLINT PEBBLES
Atkins, Kroll & Co.
Alsing, J. R. Engineering Co., Ltd.

FLUE LINING
*General Refractories Co.
Washington Brick, Lime & Sewer Pipe Co.

FORKS
*Chicago Vitreous Enamel Product Co.
*Ferro Enamel Supply Co., The
Hagan, Geo. J. Co.
National Machine Co.
*Porcelain Enamel & Mfg. Co.

FURNACES
(Clay Testing)
Denver Fire Clay Co.
Surface Combustion Co.
(Enameling)
Carborundum Company
*Chicago Vitreous Enamel Product Co.
*Ferro Enamel Supply Co., The
Hagan, Geo. J. Co.
Holcroft & Company
Parker-Russell Mining & Mfg. Co.
*Porcelain Enamel & Mfg. Co.
Surface Combustion Co.
Hoppin, C. A. & Co.
(Glass)
Amsler-Morton Co.
Dixon, H. L. Co.
Russell Engineering Co.
Simplex Engineering Co.
Toledo Engineering Co.
(Recuperative)
Russell Engineering Co.
Surface Combustion Co.
(Smelting)
*U. S. Smelting Furnace Co.
Surface Combustion Co.

Use this side of page for your memos.

GAGES
(Oil, Air, Mercury, Vacuum, Pressure and Draft)

Brown Instrument Co.
Monarch Engineering & Mfg. Co.
Taylor Instrument Co.

GAS BURNERS

Hagan, Geo. J. Co.
Harrop, Carl B.
Sharp-Schurtz Co.
Surface Combustion Co.

GAS PRODUCERS

Amsler-Morton Co.
Chapman Engineering Co.
Cooper, C. & G. Co.
Dixon, H. L. Co.
Manufacturers Equipment Co.
Morgan Construction Co.
Russell Engineering Co.
Simplex Engineering Co.
Toledo Engineering Co.
U. G. I. Contracting Co.
U. S. Cast Iron Pipe & Foundry Co.
Wood, R. D. & Co.

GEARS

Foote Bros. Gear & Machine Co.
Philadelphia Gear Works

GLASS CONTAINERS

Carr-Lowrey Glass Co.

GLASS CUTTERS

Fletcher-Terry Co.

GLASS DECOLORIZERS
(See Decolorizers)

GLASS ENGINEERS

Amsler-Morton Co.
Cruikshank Engineering Co.
Dixon, H. L. Co.
Hartford Empire Co.
Russell Engineering Co.
Simplex Engineering Co.

GLASS FEEDERS

Hartford-Empire Co.
Miller Glass Engineering Co.
O'Neil Machine Co.

GLASS FURNACES (See Furnaces, Glass)

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

You can buy anything from a complete Enamel Plant to a pair of Asbestos Gloves from us and be sure of getting good value and fair treatment.

THE FERRO ENAMEL SUPPLY CO.

Cleveland, Ohio

Builders of Complete Enamel Plants

GLASS HOUSE MACHINERY

Amsler-Morton Co., Inc.
Combustion Engineering Corp.
Hartford-Empire Co.
O'Neill Machine Co.
Simplex Engineering Co.

GLASS INSULATORS

Lynchburg Glass Corp.

GLASS MACHINERY

Hartford-Empire Co.
Knight, A. B.
Miller Machine & Mould Works
Miller, Wm. J.
O'Neill Machine Co.
The Simpson Foundry & Engineering Co.

GLASS MOULDS

Drakenfeld, B. F. & Co.
Hoosier Mould Co.
National Mould & Machine Works
Overmyer Mould Co.
Toledo Mould Co., The
Zanesville Mould Co.

GLASS LINED TANKS

Pfaulder Co.

GLAZES

Drakenfeld, B. F. & Co.
***Ferro Enamel Supply Co., The**
***Hanovia Chemical & Mfg. Co.**
Hommel, O. Co.
Innis, Speiden Co.
***Porcelain Enamel & Mfg. Co.**
***Vitro Mfg. Co.**

GLAZING MACHINES

***Ceramic Machinery Co.**
Drakenfeld, B. F. & Co.

GLOVES

(Asbestos)

***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co., The**

GOGGLES

***Ferro Enamel Supply Co., The**
Willson Goggles, Inc.

GRANULATORS

Chambers Brothers Co.

GRAPHITE TUBES

Brown Instrument Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

GRATES AND GRATE BARS

*Crossley Machine Co.
Eagle Iron Works
*Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

GRINDING APPARATUS

*Crossley Machine Co.
Hardinge Company
International Clay Machinery Co.
Lancaster Iron Works
Mine & Smelter Supply Co.
*Mueller Machine Co.
Straub, A. W. Co.

GRINDING MILLS

Straub, A. W. Co.

HAULAGE SYSTEMS

Cleveland Electric Tramrail Division
Eagle Iron Works
Harrop, Carl B.
Jeffrey Manufacturing Co.
Russell Engineering Co.

HOISTS
(Electric)

Cleveland Electric Tramrail Division
Eagle Iron Works
Lancaster Iron Works
Link-Belt Company

HYDRAULIC PUMPS

Hydraulic Press Mfg. Co.

HYDROMETERS

Taylor Instrument Companies

HYDROSEPARATORS

Dorr Company, The

HYGROMETERS

Brown Instrument Co.
Taylor Instrument Companies

Use this side of page for your memos.

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INDICATORS
(Temperature, Recording)

Brown Instrument Co.
Engelhard, Chas. Inc.
Leeds & Northrup Co.
Republic Flow Meters
Taylor Instrument Companies
Thwing Instrument Co.
Wilson-Maeulen Co.

INSULATION
(Bricks, Powder, Etc.)

Armstrong Cork & Insulation Co.
Celite Products Co.
Feather-Stone Insulation Co.
U. G. I. Contracting Co.

JIGGERS

Bucher Smith Company
Cain Machine Company
*Crossley Machine Co.
*Hadfield-Penfield Steel Co.
International Clay Machinery Co.
Ideal Foundry & Machine Co.
Ivens, W. H. Sons Co.
*Mueller Machine Co.
Patterson Foundry & Machine Co.

KILNS
(China and Pottery)

Denver Fire Clay Co.
Harrop, Carl B.
Holcroft & Co.
Russell Engineering Co.
Surface Combustion Co.

(Enamel)

Holcroft & Company
Surface Combustion Co.

(Iron Parts)

*Crossley Machine Co.
Manufacturers Equipment Co.

(Rotary)

Christie, L. R. Co.
Vulcan Iron Works

(Tunnel)

American Dressler Tunnel Kilns, Inc.
Ceramic Engineering Co.
*Ceramic Machinery Company
Harrop, Carl B.
International Clay Machinery Co.
Marlow Tunnel Kilns
Russell Engineering Co.
Surface Combustion Co.

(Tunnel, Periodic, Compartment, Continuous)

Harrop, Carl B.
Russell Engineering Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

LAYING MIXTURES
(Refractory, Molding, Patching)

*General Refractories Co.
Harbison-Walker Refractories Co.
Laclede-Christy Clay Products Co.
*Massillon Refractories Co.
Massillon Stone & Fire Brick Co.
Norton Company
Reading Fire Brick Works
U. G. I. Contracting Co.

LININGS
(Furnace)

Carborundum Company
*General Refractories Co.
Norton Company

LEERS

Amsler-Morton Co., Inc.
Carborundum Co.
Cruikshank, J. W. Engineering Co.
Dixon, H. L. Co.
Hartford-Empire Co.
Russell Engineering Co.
Simplex Engineering Co.
Surface Combustion Co.
Toledo Engineering Co.

MACHINERY
(Used)

Consolidated Products Co., Inc.

MAGNETIC SEPARATORS
(Pulleys, Drums, Concentrators)

Bennett, A. J.
Dings Magnetic Separator Co.
K. and B. Co.

MAGNETS
(Electro, Safety, Conveyor)

Dings Magnetic Separator Co.
*Mueller Machine Co.
Patterson Foundry & Machine Co.

MILLS
(Ball, Pebble, Tube, Conical, Dust, Rod, Chaser)

Aacone Engineering Co.
Abbé Engineering Co.
Cain Machine Co.
*Ceramic Machinery Co.
*Crossley Machine Co.
Denver Fire Clay Co.
*Ferro Enamel Supply Co.
*Hadfield-Penfield Steel Co.
Hardinge Company
McDanel Refractory Porcelain Co.
Macleod Co.
Mine & Smelter Supply Co.
*Mueller Machine Co.
*Porcelain Enamel & Mfg. Co.
Thropp, W. R. Sons Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY

MILLS
(Color and Glaze)

*Crossley Machine Co.

MIXING MACHINES

Chambers Brothers Co.
*Crossley Machine Co.
*Mueller Machine Co.

MOTORS

*Ferro Enamel Supply Co., The
General Electric Co.
Monarch Engineering & Mfg. Co.
Westinghouse Electric & Mfg. Co.

MOLDS
(See Dies)

MUFFLES
(Furnace)

Carborundum Company
General Electric Co.
*Massillon Refractories Co.
Norton Company
Parker Russell Mining & Mfg. Co.
*Porcelain Enamel & Mfg. Co.

OIL SYSTEMS
(See also Burners)

(Fuel)

Best, W. N. Corp.
Dempsey Furnace Co.
*Ferro Enamel Supply Co., The
Geist Manufacturing Co.
Hauck Manufacturing Co.
Harrop, Carl B.
Lalor Fuel Oil System Co.
Morse Fuel Oil System
National Airoil Burner Co.
Russell Engineering Co.
Surface Combustion Co.

OPTICAL PYROMETERS AND INSTRUMENTS

Bausch & Lomb Optical Co.
Leeds & Northrup Co.
Scientific Materials Co.
Thwing Instrument Co.

OVENS
(Enameling and Annealing)

Monarch Engineering & Mfg. Co.
Proctor & Schwartz, Inc.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

CLAY MACHINERY!

SAGGER ROOM
Grog Pans
Pug Mills
Sagger Presses
Wad Mills
Grog Screens

SLIP HOUSE
Blungers
Agitators
Lawns
Pumps
Filter Presses

GRINDING ROOM
Clay Crackers
Pulverizers
Cage Grinders
Dust Screens
Pebble Mills

PRESS ROOM
Tile Presses
Faience Presses
Porcelain Presses
Dies & Equipment

GREEN ROOM
Jiggers
Pull Downs
Cleaning Wheels
Batting Machines

GLAZE ROOM
Glaze Mills
Agitators
Lawns
Pumps

THE MUELLER MACHINE CO.
TRENTON, N. J.

HAVE you found this publication of value in your work, how much more valuable is the Journal which is issued monthly?

This Directory and Journal advertising places you eminently before the ceramists and creates for you a prestige that cannot be purchased for any amount of money. Let us talk over your ceramic advertising program.

AMERICAN CERAMIC SOCIETY
Advertising Department
Lord Hall, O. S. U. **Columbus, Ohio**

OXIDES
(See Raw Material and Chemical Section)

PANS
(Feeders, Steps, Yokes)
Manufacturers Equipment Co.

PANS
(Wet and Dry)
Chambers Brothers Co.
Clearfield Machine Works
***Crossley Machine Co.**
Eagle Iron Works
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co.
Lancaster Iron Works
***Mueller Machine Co.**

PICKLING EQUIPMENT
(Baskets, Racks, Etc.)
***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co., The**
***Porcelain Enamel & Mfg. Co.**

PLANERS
(Shale)
Eagle Iron Works

PLANTS
(Construction)
Austin Co.
Ceramic Engineering Co.
***Ferguson, H. K. Co.**
Harrop, Carl B.
Russell Engineering Co.

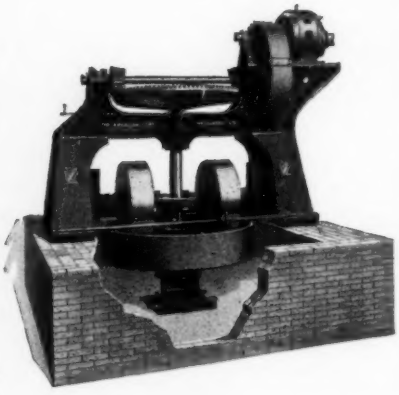
PLATE FEEDERS
Chambers Brothers Co.
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
Manufacturers Equipment Co.

POTTERY MACHINERY
(General)
Bennett, A. J.
***Ceramic Machinery Co.**
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co.
***Mueller Machine Co.**
Patterson Foundry & Machine Co.
Viking Pump Co.

Use this side of page for your memos.

*** Note their advertisement in this issue of THE CERAMIC DIRECTORY.**

A Heavy Grinding Pan



For heavier work in the Ceramic Industry we build the American No. 335 Wet Pan. We also build lighter pans for less heavy work.

Proper preparation of Clay is important in the quality of product and in all our clay preparing machinery we give a capacity unsurpassed with a speed which cuts the cost per ton of material. The up-keep also is light and power required moderate. We invite correspondence where equipment is desired.

The Hadfield-Penfield Steel Co.

Bucyrus, Ohio

Formerly The American Clay Mch. Co.

The largest and newest Pottery plants are built by Ferguson

The Homer Laughlin China Co., Newell, W. Va. (shown above), The Crescent China Co., Alliance, O., The Atlas China Co., Niles, O., The Steubenville Pottery Co., Steubenville, O., and R. Thomas & Sons, Lisbon, O., all have new pottery plants, and The H. K. Ferguson Co., designed and built all of them.

The Ferguson Company designs and builds industrial plants and *guarantees* the design, the construction, the cost and the delivery date.

If you are contemplating a new plant or an addition, talk with Ferguson first.

The H. K. Ferguson Company, 4900 Euclid Building, Cleveland, Ohio

Ferguson
GUARANTEED BUILDINGS

PRESS OIL

Richards, Co. H. N.

PRESSES

(Decorating)

***Crossley Machine Co.**

(Filter)

Cain Machine Co.
***Ceramic Machinery Co.**
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
***Mueller Machine Co.**
Patterson Foundry & Machine Co.
Shriver, T. & Co.
Sperry, D. R. & Co.

(Sagger)

Bonnot Company
***Ceramic Machinery Co.**
Chambers Brothers Co.
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
Hydraulic Press Mfg. Co., The
***Mueller Machine Co.**
Patterson Foundry & Machine Co.
Watson-Stillman Co.

(Tile)

***Ceramic Machinery Co.**
***Crossley Machine Co.**
Hydraulic Press Mfg. Co., The
International Clay Machinery Co.

PROPELLERS

(Tunnel Kiln)

***Ceramic Machinery Co.**

PUG MILLS

Cain Machine Co.
Chambers Brothers Co.
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co
***Mueller Machine Co.**

PULVERIZERS

American Pulverizer Co.
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
Hardinge Co.
***Mueller Machine Co.**

PUMPS

Cain Machine Co.
***Ceramic Machinery Co.**
***Crossley Machine Co.**
Denver Fire Clay Co.
Dorr Company, The
Hydraulic Press Mfg. Co.
Monarch Engineering & Mfg. Co.
***Mueller Machine Co.**
Viking Pump Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

GENERAL REFRACTORIES COMPANY

Philadelphia, Pa.

PRODUCTS

Fire Clay, Silica, Magnesite, and
Chrome Brick
Dead—Burned Magnesite
Magnesite Cement (or Furnace Magnesite)
Lump or Ground Chrome Ore
Chrome Cement
Ground Ganister
Silica Cement
Ground Fire Clay
High Alumina Super-Refractories
High Temperature Cement

Sales Offices:

Philadelphia, Pittsburgh, Cleveland, Detroit
New York, Chicago, Boston, Buffalo

Pacific Coast Representative:
Richard S. Jensen Co.
Los Angeles, Cal.

Canadian Representative:
Webster & Sons, Ltd.
Montreal, Canada

Texas and Mexico Representative:
L. L. Schofield, Eagle Pass, Texas

Works:

Ableman, Wis.	Danville, Ill.	Mill Hall, Pa.	Rockdale, Ill.
Baltimore, Md.	Hitchins, Ky.	Sproul, Pa.	Sand Ridge, Pa.
Beech Creek, Pa.	Joliet, Ill.	Olive Hill, Ky.	West Decatur, Pa.
Claysburg, Pa.	Karthaus, Pa.	Orviston, Pa.	Mt. Union, Pa.

PUSHERS
(Car—Hydraulic)

Harrop, Carl B.

PYROMETER TUBES
(Insulating and Protection)

Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Wilson-Maeulen Co.

PYROMETERS
(Complete Recording and Indicating)

Bristol Co.
Brown Instrument Co.
***Chicago Vitreous Enamel Product Co.**
Denver Fire Clay Co.
Chas. Engelhard, Inc.
***Ferro Enamel Supply Co., The**
Leeds & Northrup Co.
***Porcelain Enamel & Mfg. Co.**
Republic Flow Meters Co.
Taylor Instrument Companies
Wilson-Maeulen Co.

RECORDERS
(Temperature)

Bristol Company
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
Republic Flow Meters Co.
Taylor Instrument Companies
Wilson-Maeulen Co.

RECUPERATORS

Amsler-Morton Co.
Calorizing Company, The
Russell Engineering Co.
Surface Combustion Co.

REFRACTORIES
(Kiln and Glass House)

Carborundum Company
Carr-Lowrey Glass Co.
Chicago Retort and Fire Brick Co.
Dover Fire Brick Co.
Electrical Refractories Co.
***General Refractories Co.**
Green, A. P. Fire Brick Co.
Harbison-Walker Refrac. Co.
Haws Refractories Co.
Kier Fire Brick Co.
Laclede-Christy Clay Products Co.
***Massillon Refractories Co.**
Massillon Stone & Fire Brick Co.
Mitchell Clay Mfg. Co.
Norton Company
Queen's Run Refractories Co.
Reading Fire Brick Works
Russell Engineering Co.
Standard Fire Brick Co.
Vitrefrax Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

REGULATORS
Leeds & Northrup Co.
Taylor Instrument Companies

REPAIR PARTS
***Crossley Machine Co.**
Manufacturers Equipment Co.

REPRESSES
Chambers Brothers Co.
***Hadfield-Penfield Steel Co.**
International Clay Machinery Co.
Lancaster Iron Works

ROPE
(Wire)
Hazard Mfg. Co.
Roebling's, J. Sons Co.

RUBBER LININGS
(Mills)
Goodrich, B. F. Rubber Co.

SAGGER PRESSES
(See Presses)

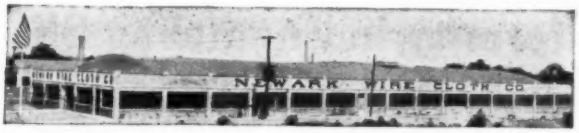
SAND BLAST EQUIPMENT
***Chicago Vitreous Enamel Product Co.**
***Ferro Enamel Supply Co.**
Koven & Brother, L. O. Inc.
MacLeod Company, The
Mott Sand Blast Mfg. Co.
***Porcelain Enamel & Mfg. Co.**

SCREENS
***Crossley Machine Co.**
***Hadfield-Penfield Steel Co.**
Hendrick Manufacturing Co.
Link-Belt Co.
Manufacturers Equipment Co.
***Newark Wire Cloth Co.**
Orville Simpson Co.
W. S. Tyler Company, The

SEPARATORS
(Centrifugal)
(Air-Oil)
***Chicago Vitreous Enamel Product Co.**
Gay, Rubert M. Co.

Use this side of page for your memos.

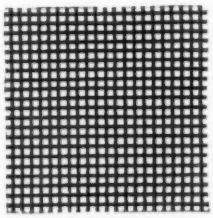
* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

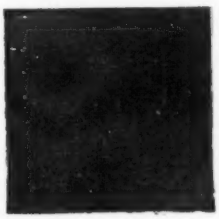


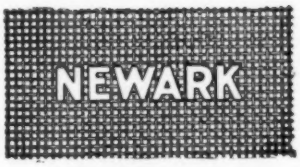
Our new factory on Verona Ave., Newark, N. J.

Wire Cloth, Sieves, and Screens,

for all Ceramic Uses







Double Crimp

Put your WIRE CLOTH problems in our hands and be assured of

Accurate Spacing
Exact Diameter
Any Metal
Any Length
Standard Widths in Stock
Special Widths to Order
PROMPT Service

NEWARK WIRE CLOTH

is now made of all metals: Aluminum, Brass, Copper, Bronze, Phosphor Bronze, Nickel, Steel, Monel Metal, Silver, Gold, Platinum, Nichrome and Special Alloys.

Newark Wire Cloth Co.

355-369 Verona Ave.,
Newark, N. J.

Uniformity in Enameling Sheets Reduces Culls

ARMCO-INGOT IRON
The Purest Iron Made
"Make Comparative Analyses"

ARMCO
Ingot Iron

Uniformity, chemically and physically, in sheets for enameling is the primary requisite in the reduction of culls. **ARMCO** Ingot Iron has these important characteristics.

ARMCO Ingot Iron Enameling sheets are degasified. The enameler can do his finished work without fear of warping, or blistering.

The surface of ARMCO Ingot Iron Enameling Sheets is velvety. The base metal grips and retains the enamel coating.

By using this iron, enamelers have reduced culls to a minimum. For uniform results, year after year, ARMCO Ingot Iron has no equal.

ASK FOR A SAMPLE OF ENAMELING STOCK

To prove to you the economy of using ARMCO Ingot Iron Sheets we offer a generous sample. You will be impressed by the saving you can make.

THE AMERICAN ROLLING MILL CO.,
MIDDLETOWN, OHIO
(Export)
ARMCO International Corporation
Cable Address— ARMCO, Middletown

THE AMERICAN ROLLING MILL CO.,
MIDDLETOWN, OHIO
Please send us a sample of ARMCO Ingot Iron Enameling Stock.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....
(The Ceramic Directory of the American Ceramic Society '25)

SHAPES
(Special Refractory)
*General Refractories Co.
Laclede-Christy Clay Products Co.
*Massillon Refractories Co.
Norton Company
Queen's Run Refractories Co.

SHEET STEEL
(Enameling)
*American Rolling Mill Co.
*Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

SHOVELS
Wyoming Shovel Works

SLIP HOUSES
*Crossley Machine Co.
*Mueller Machine Co.

SIEVES
(Testing)
*Newark Wire Cloth Co.
W. S. Tyler, The Co.

SLABS
(Furnace)
*General Refractories Co.
Norton Company

SMELTERS
*Ferro Enamel Supply Co.
Parker Russell Mining & Mfg. Co.
Surface Combustion Co.
*U. S. Smelting Furnace Co.

SPRAYING EQUIPMENT
(Tanks, Guns, Tables, Booths)
Binks Spray Equipment Co.
*Chicago Vitreous Enamel Product Co.
DeVilbiss Mfg. Co., The
*Ferro Enamel Supply Co.
Macleod Company, The
*Porcelain Enamel & Mfg. Co.

STENCILS
(Zinc-paper)
*Chicago Vitreous Enamel Product Co.

STOKERS
Combustion Engineering Co.
Sanford Riley Stoker Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

TACHOMETERS
Brown Instrument Co.
Taylor Instrument Companies

TANK BLOCKS
(See Refractories)

TANKS
***Crossley Machine Co.**
Hauser Stander Tank Co.
Koven, L. O. & Bro.
Monarch Engineering & Mfg. Co., The
(Steel, Concrete Storage)
Harrop, Carl B.
Russell Engineering Co.

TESTING
Harrop, Carl B.
Robinson, Louis G.
Sharp-Schurtz Co.
Wilkins, W. W.

THERMOCOUPLES
(Base and Noble Metal)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
***Porcelain Enamel & Mfg. Co.**
Taylor Instrument Companies
Wilson-Maeulen Co.

THERMOMETERS
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
Taylor Instrument Companies
Wilson-Maeulen Co.

THERMOSTATS
Taylor Instrument Companies

THICKENERS
Dorr Company, The

TILE
(Boiler and Stoker)
***General Refractories Co.**
Laclede-Christy Clay Products Co.
(Recuperator)
Carr-Lowrey Glass Co.
***General Refractories Co.**
Russell Engineering Co.
Surface Combustion Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

TILE MACHINERY

*Ceramic Machinery Co.
*Crossley Machine Co.
*Hadfield-Penfield Steel Co.
Hydraulic Press Mfg. Co.
*Mueller Machine Co.
Patterson Foundry & Machine Co.

TIMING SYSTEMS
(Employees', alarm)

Stromberg Electric Co.

TRUCKS

*Ferro Enamel Supply Co., The
Manufacturers Equipment Co.
Plimpton Lift Truck Co.

TUBES
(Insulation and Pyrometer)

Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Wilson-Maeulen Co.

UNLOADERS

Manufacturers Equipment Co.

VACUUM PUMPS

*Mueller Machine Co.

VALVES

*Crossley Machine Co.
Manufacturers Equipment Co.

VENTS (Air-Kiln)

Manufacturers Equipment Co.

WAD MACHINES

*Crossley Machine Co.
Patterson Foundry & Machine Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

WASHING MACHINES

*Crossley Machine Co.
*Mueller Machine Co.

WHEELS

(Polishing)

*Crossley Machine Co.
*Mueller Machine Co.
Patterson Foundry & Machine Co.

WHEEL BARROWS

Manufacturers Equipment Co.

WHIRLERS

(Pottery)

*Crossley Machine Co.
Patterson Foundry & Machine Co.

WIRE CLOTH

Audubon Wire Cloth Co.
*Newark Wire Cloth Co.
Tyler, W. S. Co.

Use this side of page for your memos.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Alphabetical List of Firms and Addresses

Aacone Engineering Co.
17 Steiner Place, N. Plainfield, N. J.

Abbé Engineering Co.
50 Church St., New York City

Acheson Graphite Co.
Niagara Falls, N. Y.

Adirondack Diatomaceous Earth Co.
Herkimer, N. Y.

Adirondack Spar Mining Co.
Ticonderoga, N. Y.

W. R. Adler Co.
Chicago, Ill.

Alabastine Company
Grand Rapids, Mich.

Albany Clay Slip Co.
93 State St., Albany, N. Y

Alberhill Coal and Clay Co.
Alberhill, Calif.

Albion Kaolin Co.
Hephzibah, Ga.

J. R. Alsing Engineering Co., Ltd.
50 Church Street, New York City

Aluminium Co. of America
Oliver Bldg., Pittsburgh, Pa.

Aluminum Ore Co.
E. St. Louis, Ill.

American Blower Co.
Detroit, Mich.

American Dressler Tunnel Kilns, Inc.
1740 East 12th St., Cleveland, Ohio

American Emery Wheel Works
Providence, R. I.

American Encaustic Tiling Co.
Zanesville, Ohio

American Glue Co.
121 Beverly St., Boston, Mass.

American Gypsum Co.
612 Mutual Life Bldg., Buffalo, N. Y.

American Grinding Co.
Los Angeles, Calif.

American Lava Corp.
Chattanooga, Tenn.

American Manganese Co.
Dunbar, Pa.

American Metal Co.
61 Broadway, New York, N. Y.

American Pulverizer Co.
St. Louis, Mo.

American Resistor Co.
Milwaukee, Wis.

***American Rolling Mill Co.**
Middletown, Ohio

American Rutile Co.
Jenifer Bldg., 402 7th St., N. W.
Washington, D. C.

***American Trona Corporation**
233 Broadway, New York City

Amsler-Morton Co.
Fulton Bldg., Pittsburgh, Pa.

Anderson Foundry & Machine Co.
Anderson, Ind.

Anness & Potter Fire Clay Co.
Woodbridge, N. J.

The Anthony Co.
Long Island City, N. Y.

The Armstrong Cork & Insulation Co.
Pittsburgh, Pa.

Ashland Fire Brick Co.
Ashland, Ky.

Atkins, Kroll & Co.
260 California St., San Francisco, Calif.

The Austin Company
14230 Euclid Ave., Cleveland, Ohio

Audubon Wire Cloth Co.
Audubon, N. J.

Babcock & Wilcox Co.
85 Liberty St., New York City

H. W. Bacon
Edgemont, S. D.

M. J. Bacon
Ione, Calif.

Bailey Drug Co.
Zanesville, Ohio

J. T. Baker Chemical Co.
Phillipsburg, N. J.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Balfour, Guthrie & Co.
Balfour Bldg., San Francisco, Calif.

M. L. Barrett Co.
233 W. Lake St., Chicago, Ill.

H. H. Barton & Sons Co.
109 S. Third St., Philadelphia, Pa.

Basic Chemical Mfg. Corp.
Alton, Ill.

Batelle & Renwick
80 Maiden Lane, New York City

Baugh & Sons Co.
20 Delaware Ave., Philadelphia, Pa.; Baltimore, Md.

Bausch, Fred E.
1105 Chemical Bldg.
St. Louis, Mo.

Bausch & Lomb Optical Co.
Rochester, N. Y.

Beaver Products Co., Inc.
Buffalo, N. Y.

Beaver Products Co.
Fort Dodge, Iowa

Beaver Products Co.
American Cement Plaster Div., Blue Rapids, Kans.

Bedford Mining Co.
Bedford, N. Y.

Fred S. Bell
St. Louis, Mo.

Belleville Enameling & Stamping Co.
110 S. 16th St., Belleville, Ill.

Benjamin Electric Mfg. Co.
Des Plaines, Ill.

Bentonite Products Co.
Belle Fourche, S. D.

A. J. Bennett
Trenton, N. J.

Berkeley Glass Sand Co.
Berkeley Springs, W. Va.

W. N. Best Corporation
11 Broadway, New York City

Bichler Brothers,
Gladstone, Mich.

Big Savage Fire Brick Co.
Frostburg, Md.

Binks Spray Equipment Co.
3129 Carroll Ave., Chicago, Ill.

S. Birish
New Brunswick, N. J.

Bloomfield Clay Co.
Metuchen, N. J.

Blue Corundum Mining Co.
Easton, Pa.

Bonnot Company
Canton, Ohio

Braun Corporation
Los Angeles, Calif.

W. A. Bree
St. Louis, Mo.

S. G. Brinkman
Fords, N. J.

The Bristol Company
Waterbury, Conn.

The Brown Instrument Co.
4505 Wayne Ave., Philadelphia, Pa.

Bucher Smith Co.
Chester, West Va.

Buckman & Pritchard, Inc.
Mineral City, Fla.; 94 Fulton St., New York City

Buffalo Forge Co.
Buffalo, N. Y.

Jas. S. Burroughs
7 Water St., New York City

The L. H. Butcher Co.
2030 Bay St., Los Angeles, Calif.; 253 Front St., New York City

E. L. Butler Clay Co.
111 W. Washington St., Chicago, Ill.

Cain Machine Co.
E. Liverpool, O.

Caliproducts Co.
Los Angeles, Calif.

The Calorizing Co.
Wilkinsburg, Pa.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Carbola Chemical Co., Inc.
299 Ely Ave., Long Island City, N. Y.

Carborundum Company
Niagara Falls, N. Y.

Philip Carey Co.
Cincinnati, Ohio

Cardiff Gypsum Co.
Fort Dodge, Iowa

C. & G. Copper Co.
Mt. Vernon, Ohio

Carr-Lowrey Glass Co.
Baltimore, Md.

Carrier Engineering Co.
Newark, N. J.

Richard L. Cawood Co.
East Liverpool, Ohio

Cayuga Rock Salt Co., Inc.
Myers, N. Y.

Cedarville Lime Co.
Cedarville, Ohio

Celite Products Co.
53 W. Jackson Blvd., Chicago, Ill.;
11 Broadway, New York City

Centerville Gypsum Co.
Centerville, Iowa

***Central of Georgia Ry.** (J. M. Mallory)
Savannah, Ga.

Central Scientific Co.
Chicago, Ill.

Central Silica Co.
Zanesville, Ohio

Ceramic Engineering Co.
Schultz Bldg., Columbus, Ohio

***Ceramic Machinery Co.**
Hamilton, Ohio

Chambers Brothers Co.
Philadelphia, Pa.

Champion Sillimanite Corp.
Bishop, Inyo Co., Calif.

Champion Spark Plug Co.
Detroit, Mich.

Chapman Engineering Co.
Mt. Vernon, Ohio

Chateaugay Ore & Iron Co.
Scranton, Pa.

Cherokee Mining Co.
Fourth National Bank Bldg., Macon, Ga.

Cheshire White Quartz Sand Co.
Cheshire, Mass.

Chicago Copper & Chemical Co.
111 W. Jackson Blvd., Chicago, Ill.

Chicago Crucible Co.
Chicago, Ill.

Chicago Retort and Fire Brick Co.
Ottawa, Ill.

***Chicago Vitreous Enamel Product Co.**
Cicero, Ill.

L. R. Christie Co.
307 4th Ave., Pittsburgh, Pa.

Clearfield Machine Works
Clearfield, Pa.

Cleveland Electric Tramrail Division of Cleveland Crane & Eng. Co.
Wickliffe, Ohio

Cleveland Feldspar & Products Co.
10220 Meech Ave., Cleveland, Ohio

Clinch Mountain Silica Sand Co.
Mendota, Va.

Clinchfield Products Corp.
350 Madison Ave., New York City

Clinton Metallic Iron Ore Co.
Clinton, N. J.

Clinton Metallic Paint Co.
Clinton, N. Y.

Clipper Belt Lacer Co.
Grand Rapids, Mich.

Colonial Clay Co.
Warriors Mark, Pa.

Columbia Products Co.
Garfield Bldg., Cleveland, Ohio

Combustion Engineering Co.
43 Broad St., New York City

Connersville Blower Co.
Connersville, Ind.

Consolidated Products Co., Inc.
15 Park Row, New York City

Consolidated Slip Clay Co.
295 W. Lawrence St., Albany, N. Y.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Consumers' Co.
111 W. Washington St., Chicago, Ill.

Consumers' Lime Co.
Fairmont, W. Va.

Cooley Clay Co.
Hickory, Ky.

H. F. Coors
5469 Ninth St., Los Angeles, Calif.

Richard Coulston, Inc.
95 Madison Ave., New York City

Crescent Refractories Co.
Curwensville, Pa.

Crescent Silica Co.
Chicago, Ill.

***The Crossley Machine Co.**
State & Chestnut Sts., Trenton, N. J.

Crossman Co.
South Amboy, N. J.

Croton Chemical Co.
14 Cedar St., New York City

Croxall Chemical Co.
East Liverpool, Ohio

J. W. Cruikshank Engineering Co.
230 Fifth Ave., Pittsburgh, Pa.

Crystal Bldg. Prod. Corp.
Chicago, Ill.

Chas. B. Crystal & Sons
11 Cliff St., New York City

J. W. Cummings Feldspar Co.
Baltimore, Md.; Bathe, Me.

A. Daigger & Co.
54 W. Kinzie St., Chicago, Ill.

The Daniel Clay Co.
Hopkins, S. C.

H. Dearborn's Sons
Anamosa, Iowa

Deckers Creek Sand & Stone Co.
Stargison, W. Va.

Wm. E. Dee Co.
Oak Hill, Ohio

Delta Contracting Co.
Escanaba, Mich.

Dempsey Furnace Co.
Jersey City, N. J.

The Denver Fire Clay Co.
P. O. Box 1107, Denver, Colo.

Denver Sewer Pipe & Clay Co.
611 Interstate Trust Bldg., Denver, Colo.

The DeVilbiss Manufacturing Co.
Toledo, Ohio.

Diamond Alkali Co.
Wabash Bldg., Pittsburgh, Pa.

W. S. Dickey Clay Mfg. Co.
200 N. Y. Life Bldg., Kansas City, Mo.

Dill Coppage, Inc.
1904 Atlantic St., Los Angeles, Calif.

Dilts Brothers
Roseville, Ohio

Dings Magnetic Separator Co.
Milwaukee, Wis.

Dixie Fireproofing Co.
Denver, Colo.; Carrs Station, Ga.

H. L. Dixon Co.
Pittsburgh, Pa.

Joseph Dixon Crucible Co.
Jersey City, N. J.

Stanley Doggett, Inc.
99 John and 11-13 Cliff St., N. Y. City

Dolese Brothers Co.
Davenport, Iowa

Dolomite Products Co.
1110 Euclid Ave., Cleveland, Ohio

The Dorr Company
247 Park Ave., New York City

Dover Fire Brick Co.
Cleveland, Ohio

B. F. Drakenfeld & Co.
50 Murray St., New York City

Driver-Harris Co.
Harrison, N. J.

Dunbar & Sullivan Dredging Co.
Detroit, Mich.

* Note their advertisement in this issue of THE CERAMIC DIRECTORY.

Du Pont Chemical Works
120 Broadway, New York City

Eagle Iron Works
Des Moines, Iowa

Eagle Picher Lead Co.
208 S. La Salle St., Chicago, Ill.

Eagle Point Lime Works
Dubuque, Iowa

Eastern Magnesia Talc Co., Inc.
441 Lexington Ave., New York City

Eastman Kodak Company
Rochester, N. Y.

Ebsary Gypsum Co., Inc.
Scottsville, N. Y.

Edgar Bros. Co.
Metuchen, N. J.

Edisto Kaolin Co.
Steedman, S. C.

Electrical Refractories Co.
East Palestine, Ohio

Elk Fire Brick Co.
St. Marys, Pa.

Ellis Park Stone Co.
Cedar Rapids, Iowa

Empire Clay Mining Co.
534 Providence St., Albany, N. Y.

Empire Gypsum Co.
319 Cutler Bldg., Rochester, N. Y.

Chas. Engelhard, Inc.
30 Church St., New York City

English China Clays Sales Corp.
33 W. 42nd St., New York City

Enterprise White Clay Co.
Real Estate Trust Co. Bldg., Philadelphia, Pa.

R. R. Erato
821 E. Girard Ave., Philadelphia, Pa.

Erie City Boiler Works
Erie, Pa.

Erwin Feldspar Corp.
Erwin, Tenn.

Eureka Flint & Spar Co.
Greenwood Ave. and Lewis St., Trenton, N. J.

Excelsior Ball Clay Co.
Hickory, Ky.

Exolon Co., Blaisdell, N. Y.

Fair Valley Clay Co.
Altoona, Pa.

Fairview Fluorspar & Lead Co.
Rosiclare, Ill.

Farber Fire Brick Co.
Farber, Mo.

R. N. Farnsworth
Lancaster, Mass.

Feather-Stone Insulation Co.
611 East 4th St., Los Angeles, Calif.

Federal Clay Products Co.
Mineral City, Ohio

Federal Enamel Supply Co.
Cleveland, Ohio

***H. K. Ferguson Co.**
Cleveland, Ohio

***Ferro Enamel Supply Co.**
Cleveland, Ohio

Ferro Manganese Co.
341 Montgomery St., San Francisco, Calif.

Wm. Finkell Co.
100 William St., New York City

Robert Spencer Finney
303 W. 80th St., New York City

Fletcher-Terry Co.
Forestville, Conn.

Florida China Clay Co.
Leesburg, Fla.; Easton, Pa.

Florida Diatomite Co.
Clermont, Fla.

Foote Bros. Gear & Mch. Co.
Curtis St., Chicago, Ill.

Foote Mineral Co., Inc.
107 North 19th Street, Philadelphia, Pa.

J. B. Ford Co.
Wyandotte, Mich.

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A. C. Forney
Belle Fourche, S. D.

Fort Montgomery Iron Corp.
20 Vesey St., New York City

France Stone Co.
1800 2nd National Bank, Toledo, Ohio

***Chas. M. Franzheim Co.**
Wheeling, W. Va.

E. M. Freese & Co.
Galion, Ohio

Frink Decolorizer Co.
Lancaster, Ohio

Frontenac Floor & Wall Tile Co.
Kingston, Ont., Can.

G. Frost
P. O. Box 646, East Liverpool, Ohio

Fruitland Iron Ore Co.
Easton, Pa.

W. P. Fuller & Co.
136 N. Los Angeles St., Los Angeles, Calif.; 301 Mission St., San Francisco, Calif.

Gandy Belting Co.
740 W. Pratt St., Baltimore, Md.

Garfield Fire Clay Co.
Robinson, Pa.

Garrard & Haynes
Iuka, Miss.

Gates Fire Clay Co.
Colchester, Ill.

Rubert M. Gay Co.
114 Liberty St., New York City

Geist Manufacturing Co.
Atlantic City, N. J.

General Abrasive Co.
Niagara Falls, N. Y.

General Basic Products Co.
E. Marginal Way, Seattle, Wash.

General Chemical Co.
40 Rector St., New York City

General Electric Co.
Schenectady, N. Y.

General Magnesite & Magnesia Co.
Venango, Balfour and Kingston Sts., Philadelphia, Pa.

***General Refractories Co.**
117 S. Sixteenth St., Philadelphia, Pa.

***Genesee Feldspar Co.**
Rochester, N. Y.

W. F. George Chemical Co.
45 Broadway, New York City

Geo. H. Gillespie Co., Ltd.
Madoc, Ontario, Canada

J. Goebel & Co.
67 Cortlandt St., New York City

Golding-Keene Co.
Keene, N. H.

***Golding Sons Co.**
Trenton, N. J.; East Liverpool, Ohio

B. F. Goodrich Rubber Co.
Akron, Ohio

Goodwin Supply Co.
East Liverpool, Ohio

Goodyear Tire & Rubber Co.
Akron, Ohio

W. R. Grace & Co.
7 Hanover St., New York City

Grand View Fire Clay Co.
St. Louis, Mo.

Grasselli Chemical Co.
Guardian Bldg., Cleveland, Ohio

Great Western Silica Co.
Ellensburg, Wash.

A. P. Green Fire Brick Co.
Box 203, Mexico, Mo.

Green Hill Mining Co.
8 Park St., Gouverneur, N. Y.

Grey Brothers
St. James, Mo.

***Hadfield-Penfield Steel Co.**
Bucyrus, Ohio

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Geo. J. Hagan Co.
Chamber of Commerce Bldg.
Pittsburgh, Pa.

Hammill & Gillespie, Inc.
240 Front St., New York City

Hampton Cutter Co.
Woodbridge, N. J.

Hanna Paint Co.
Columbus, Ohio.

***Hanovia Chemical & Mfg. Co.**
Chestnut St. & N. J. R. R. Ave.,
Newark, N. J.

Harbison-Walker Refractories Co.
Farmers' Bank Bldg., Pittsburgh, Pa.

Hardinge Co.
120 Broadway, New York City

Harris Clay Co., The
Dillsboro, N. C.

Carl B. Harrop
416 Majestic Bldg., Columbus, Ohio

Harshaw, Fuller and Goodwin Co.
Cleveland, Ohio

Hartford-Empire Co.
Hartford, Conn.

John W. Hasburg & Co.
1119 N. La Salle St., Chicago, Ill.

Hauck Manufacturing Co.
136 Tenth St., Brooklyn, N. Y.

Hayes Run Fire Brick Co.
Orviston, Pa.

Hauser-Standard Tank Co.
2116 Division St., Cincinnati, Ohio

Haws Refractories Co.
Johnstown, Pa.

Hazard Manufacturing Co.
Wilkes-Barre, Pa.

Harry S. Haze
330 S. Franklin St., Chicago, Ill.

Hazel-Atlas Glass Co.
Great Capon, W. Va.

Hendrick Manufacturing Co.
Carbondale, Pa.

John Herzog & Son
Patterson, Ohio

Hickman, Williams & Co.
Louisville, Ky.

Hickory Ball Clay Co.
Mayfield, Ky.

Highlands Fire Clay Co.
Mackind & Berthold Ave., St. Louis,
Mo.

John W. Higman Co.
29 Broadway, New York City

Edward Hill Co.
21 E. 40th St., New York City

Hillside Fluorspar Mines
Rosiclare, Ill.

Hinde & Dauch Paper Co.
Sandusky, Ohio

Holcroft & Co.
6545 Epworth Blvd., Detroit, Mich.

Donald R. Holm
Los Angeles, Calif.

O. Hommel Co.
209 Fourth Ave., Pittsburgh, Pa.

Homestake Mining Co.
Lead, S. D.

Hooker Electrochemical Co.
40 Wall St., New York City

Hooper Graphite Co.
Whitehall, N. Y.

Hoosier Mould Co.
Fairmont, Ind.

C. A. Hoppin Co.
Peoria, Ill.

Hoskins Mfg. Co.
Detroit, Mich.

Louis W. S. Howe
Glastonbury, Conn.

A. A. Hurst & Co.
Maquoketa, Iowa

Hydraulic Press Manufacturing Co.
Mt. Gilead, Ohio

Hy-Grade Manganese Co.
Woodstock, Va.

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Ideal Foundry & Machine Co.
Beaver Falls, Pa.

Illinois Barite Co.
Golconda, Ill.

Illinois Clay Products Co.
214 Barber Bldg., Joliet, Ill.

Illinois Kaolin Co.
Anna Natl. Bank Bldg., Anna, Ill.

Immaculate Kaolin Co.
Langley, S. C.

Imperial Belting Co.
400 N. Lincoln St., Chicago, Ill.

Import Chemical Co.
162 First St., Jersey City, N. J.

Industrial Minerals Corp., Ltd.
Bank of Hamilton Bldg., Toronto, Ont., Canada

Industrial Works
Bay City, Mich.

Ingersoll-Rand Co.
11 Broadway, New York City

Innis, Speiden Co.
46 Cliff St., New York City

International Clay Machinery Co.
Dayton, Ohio

International Lime Co.
Sumas, Wash.

International Ore & Smelting Co.
Saltillo, Coah, Mexico

International Products Co.
White Bldg., Buffalo, N. Y.

International Pulp Co.
41 Park Row, New York City

International Silica Co.
Cairo, Ill.

International Talc Co.
Gouverneur, N. Y.

Inyo Talc Co.
Keeler, Calif.

Isco-Bautz Co., Inc.
120 W. Kinzie St., Chicago, Ill.

W. H. Ivens' Sons Co.
Trenton, N. J.

J. H. Jackson Tile Co.
108 Third Ave., New York City

John H. Jackson Tile Co.
Albany, N. Y.

Jackson Mills Emery Co.
Easton, Pa.

Jeffrey Manufacturing Co.
Columbus, Ohio

Johnson-Porter Clay Co.
McKenzie, Tenn.

Wm. Johnson
207 St. James, Montreal, Canada

Jointless Fire Brick Co.
1130 Clay St., Chicago, Ill.

K. & B. Company
495 North 3rd St., Philadelphia, Pa.

Katzenbach & Bullock Co.
Trenton, N. J.

Kauffman-Lattimer Co.
Columbus, Ohio

Keasbey & Mattison Co.
Chicago, Ill.

Kelley Island Lime & Transport Co.
Leader Bldg., Cleveland, Ohio

Kentucky Clay Mining Co.
Mayfield, Ky.

Kentucky Construction & Improvement Co.
Mayfield, Ky.

Kentucky Fluorspar Co.
Marion, Ky.

Keystone Emery Mills
4325 Paul St., Philadelphia, Pa.

Kier Fire Brick Co.
Oliver Bldg., Pittsburgh, Pa.

Kingman Feldspar Co.
Kingman, Ariz.

A. B. Knight
117 E. Park Ave., Fairmont, W. Va.

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Luke Knowles
Chester, W. Va.

L. O. Koven & Bro., Inc.
Jersey City, N. J.

Kramer Bros.
319 Central Ave., Norwich, Conn.

Laclede-Christy Clay Products Co.
St. Louis, Mo.

F. E. Ladd
Fort Payne, Ala.

Lake City Clay Co.
Okahumpka, Fla.

Lalor Fuel Oil System Co.
527 Colvin St., Baltimore, Md.

Lancaster Iron Works
Lancaster, Pa.

Karl Langenbeck
1625 Hobart St., N. W., Washington, D. C.

E. J. Lavino Co.
Bullitt Bldg., Philadelphia, Pa.

Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia, Pa.

Lewis Institute
Madison & Robey Sts., Chicago, Ill.

John T. Lewis & Bro.
705 Lafayette St., Philadelphia, Pa.

Lincoln Clay Products Co.
Lincoln, Calif.

Geo. W. Lindsay
Box 1107, Denver, Colo.

Lindsay Light Co.
161 E. Brand St., Chicago, Ill.

Link-Belt Co.
910 S. Michigan Ave., Chicago, Ill.

Linwood Cement Co.
Davenport, Iowa

Thos. O. Logan
Edgemont, S. D.

W. H. Loomis Talc Corp.
173 E. Main Street, Gouverneur, N. Y.

Los Angeles Chemical Co.
2220 Santa Fe Ave., Los Angeles, Calif.

Louisville Cement Co.
Louisville, Ky.

Louisville Fire Brick Co.
Louisville, Ky.

Louthan Mfg. Co.
East Liverpool, Ohio

Lycoming Calcining Co.
12 West 4th Street, Williamsport, Pa.

Lynchburg Glass Corp.
Lynchburg, Va.

Wm. Lynn & Co.
129 Davidson St., Indianapolis, Ind.

The Macleod Company
Bogen St., Cincinnati, Ohio

Main Belting Co.
Chicago, Ill.; 1219 Carpenter St., Philadelphia, Pa.

***Maine Feldspar Co.**
Brunswick, Me.

Mallinckrodt Chemical Works
3600 North 2nd St., St. Louis, Mo.

Mandle Clay Mining Co.
Arcade Bldg., St. Louis, Mo.

***Mansfield Sheet & Tin Plate Co.**
Mansfield, Ohio

Manufacturers Equipment Co.
Dayton, Ohio

Manufacturers Mineral Co.
1107 W. Idaho St., Seattle, Wash.

Marion Shovel Co.
Marion, Ohio

Marlow Tunnel Kilns
Zanesville, Ohio

Marquette Stone Products Co.
Marquette, Iowa

Maryland Chemical Co.
Baltimore, Md.

Maryland Quartz Co.
American Bldg., Baltimore, Md.

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***Massillon Refractories Co.**
Massillon, Ohio

Massillon Stone & Fire Brick Co.
Massillon, Ohio

Master Products Co.
5756 Alba St., Los Angeles, Calif.

Mathieson Alkali Works
53 Canal St., Providence, R. I.

Maxon Premix Burner Co.
Muncie, Ind.

McDanel Refractory Porcelain Co.
Beaver Falls, Pa.

R. F. McGrory Co.
Trenton, N. J.

L. H. McHose
Perth Amboy, N. J.

McLain Fire Brick Co.
1208 Fulton Bldg., Pittsburgh, Pa.

McLanahan-Watkins Co.
Charlotte Court House, Va.

Metal and Thermit Corp.
120 Broadway, New York City

Metronite Company
Milwaukee, Wis.

Michigan Alkali Co.
21 E. 40th St., New York City

Michigan Quartz Silica Co.
Milwaukee, Wis.

Michigan Silica Co.
Rockwood, Mich.

Mifford Chemical Co.
749 S. San Pedro St., Los Angeles, Calif.

Miller Glass Engineering Co.
Swissvale, Pa.

Miller Machine & Mould Works
707 Ann St., Columbus, Ohio

Wm. J. Miller
Swissvale, Pa.

Mine & Smelter Supply Co.
42 Broadway, New York City

Mineral Point Zinc Co.
Marquette Bldg., Chicago, Ill.

Mineral Products Co.
50 Congress St., Boston, Mass.

The Mississippi Bauxite Co.
Sheffield, Ala.

Mississippi Iron Co.
St. Louis, Mo.

Missouri Fire Brick Co.
6100 Manchester Ave., St. Louis, Mo.

Mitchell Clay Mfg. Co.
5627 Manchester Ave., St. Louis, Mo.

Mitchell-Rand Mfg. Co.
18 Vesey St., New York City

A. Muirhead & Co.
Toronto, Canada

Monarch Engineering & Manufacturing Co.
Baltimore, Md.

Montgomery Porcelain Products Co.
Franklin, Ohio

Moon Clay & Kaolin Co.
Trenton, N. J.

Moore & Munger
29 Broadway, N. Y.

J. H. Morehead
Hickory Flat, Miss.

Morgan Construction Co.
Worcester, Mass.

Morgan & Horton Clay Co.
Eifort, Ohio

John J. Moroney & Co.
2825 W. Harrison St., Chicago, Ill.

Sam W. Morris
Monroe, Mich.

Morrison Clay & Coal Mines
Uhrichsville, Ohio

Morse Chain Co.
Ithaca, N. Y.

Morse Fuel Oil System Co.
Brooklyn, N. Y.

J. F. Morton, Inc.
54 S. Hermitage Ave., Trenton, N. J.

Mott Sand Blast Mfg. Co.
25 S. Clinton St., Chicago, Ill.

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C. W. Mowrey
Aladdin, Wyo.

***Mueller Machine Co.**
Trenton, N. J.

National Airoil Burner Co.
Thompson St., Philadelphia, Pa.

National Lead Co.
641 Freeman Ave., Cincinnati, Ohio.; 111 Broadway, N. Y.

National Lead & Oil Co.
Commonwealth Bldg., Pittsburgh, Pa.

National Mortar & Supply Co.
2nd National Bank Bldg., Pittsburgh, Pa.

National Mould & Machine Works
Clarksburg, W. Va.

National Sales Corporation
31 E. 13th St., Cincinnati, Ohio

***National Silica Co.**
Oregon, Ill.

National Silica Works
Berkeley Springs, W. Va.

National Supply Co.
Orleans St., Chicago, Ill.

Nephi Plaster & Mfg. Co.
907 Continental Bank Bldg., Salt Lake City, Utah

New England Quartz Co.
107 William St., New York City

New Jersey Pulverizing Co.
15 Park Row, New York City

New Jersey Zinc Sales Co.
160 Front St., New York City

New York & Pennsylvania Clay Products Co.
Rochester, N. Y.; Ridgway, Pa.

New York Pyrites Co., Inc.
25 Broad Street, New York City

New York Zinc Co., Inc.
Edwards, N. Y.

Newark China Clay Co.
Newark, N. J.

***Newark Wire Cloth Co.**
355 Verona Ave., Newark, N. J.

Niagara Gypsum Co.
597 Michigan St., Buffalo, N. Y.

Non-Metallic Minerals Corp.
1001 Mission Rd., Los Angeles, Calif.

Northern Lime Co.
Petoskey, Mich.

North River Garnet Co.
North River, N. Y.

The North State Feldspar Co.
East Liverpool, Ohio

Northwestern Magnesite Co.
Chewelah, Wash.

Norton Company
Worcester, Mass.

Oakfield Gypsum Products Corp.
Oakfield, N. Y.

Oakley Chemical Co.
22 Thames St., New York City

O'Brien & Fowler
Ottawa, Ont., Canada

Ohio Silica Co.
East Liverpool, Ohio

Ohio Valley Fluorspar Co.
Cave In Rock, Ill.

T. A. O'Leary Co.
2nd National Bank Bldg., Pittsburgh, Pa.

Old Hickory Clay & Tile Co.
Paducah, Ky.

O'Neill Machine Co.
Toledo, Ohio

Onondaga Potteries Co.
Syracuse, N. Y.

Orcas Lime Co.
Orcas Island, Wash.

Orville Simpson Co.
1230 Knowlton St., Cincinnati, Ohio

Ostrander Fire Brick Co.
Troy, N. Y.

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Ottawa Silica Co.
Ottawa, Ill.

Overmyer Mould Co.
Winchester, Ind.

Owens Bottle Co.
Toledo, Ohio

Oywhee Chemical Co.
S. Union Ave., Chicago, Ill.

Ozark Stone Quarry
Ozark, Mich.

Pacific Coast Gypsum Co.
Tacoma and Seattle, Wash.

Pacific Sanitary Mfg. Co.
67 New Montgomery St., San Francisco, Calif.

Paducah Clay Co.
Paducah, Ky.

Pfaudler Co.
Elyria, Ohio

***Paper Makers Importing Co.**
Easton, Pa.

Paragon Kaolin Co.
414 Herald Bldg., Augusta, Ga.

J. R. Parker
Langley, S. C.

Parker-Russell Mining & Mfg. Co.
St. Louis, Mo.

Patek Bros., Inc.
232 E. Water St., Milwaukee, Wis.

Patterson Foundry & Machine Co.
E. Liverpool, Ohio

Pegram Clay Co.
Carrollton, Ill.

Penland Feldspar & Kaolin Co.
Penland, N. C.

Pennsylvania Glass Sand Co.
341 Fourth Ave., Pittsburgh, Pa.

***Pennsylvania Pulverizing Co.**
Lewistown, Pa.

Pennsylvania Salt Mfg. Co.
Widener Bldg., Philadelphia, Pa.

Penn Tile Works Co.
Aspers, Pa.

A. C. Perham
West Paris, Me.

Perris Mining Co.
Ethanac, Calif.

Perth Feldspar & Mining Co.
Perth, Ont., Canada

Pettinos Bros.
25 Church St., New York City

Pewabic Pottery Co.
2161 Jefferson St. E., Detroit, Mich.

C. Pfeiffer.
Metuchen, N. J.

Chas. Pfizer & Co.
Maiden Lane, New York City

Philadelphia Drying Machinery Co.
Philadelphia, Pa.

Philadelphia Gear Works
Philadelphia, Pa.

Philadelphia Quartz Co.
121 S. 3rd St., Philadelphia, Pa.

Phoenix Gypsum Co.
621 Mutual Life Bldg., Buffalo, N. Y.

L. G. Pike
Wareham, Dorset, England

H. C. Pirrine & Son
South Amboy, N. J.

Pitts & Laughlin
311 California St., San Francisco, Calif.

Pittsburgh Plate Glass Co.
Frick Bldg., Pittsburgh, Pa.

Pittsburgh Sand Co.
Pittsburgh, Pa.

Plimpton Truck Co.
Stamford, Conn.

Joshua Poole
East Liverpool, Ohio

***Porcelain Enamel & Mfg. Co.**
Baltimore, Md.

Port Henry Iron Ore Co.
2 Rector St., New York City

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Potters Mining & Milling Co.
East Liverpool, Ohio

Potters' Supply Co.
East Liverpool, Ohio

Powers-Weightman-Rosengarten Co.
P. O. Box 1625, Philadelphia, Pa.

H. G. Preston, Co.
New Castle, Pa.

Proctor & Schwartz, Inc.
Philadelphia, Pa.

Product Sales Co.
430 Hearst Tower Bldg., Baltimore, Md.

Pueblo Clay Products Co.
Pueblo, Colo.

Quaker City Rubber Co.
Wissinoming, Pa.

Queen's Run Refractories Co.
Lock Haven, Pa.

G. E. Ramsden & Co.
Fenton, Stoke-on-Trent, England

Mose Randall
Langley, S. C.

Henry Ranstetter
Golden, Colo.

Reading Fire Brick Works
Reading, Pa.

Richard C. Remmey, Son Co.
Hedley & Del. Sts., Philadelphia, Pa.

Republic Flow Meters Co.
2240 Diversey Parkway, Chicago, Ill.

Retsof Mining Co.
Scranton Life Bldg., Scranton, Pa.

L. Reusch & Co.
23 Union Sq. E., New York City

H. N. Richards Co.
1203 E. State St., Trenton, N. J.

John Richardson & Co.
88 Broad St., Boston, Mass.

W. D. Richardson
Ceramic Engineering Co., Schultz Bldg., Columbus, Ohio

River Feldspar & Milling Co.
Box 581, Middletown, Conn.

G. S. Robins Co.
St. Louis, Mo.

Louis G. Robinson
31 E. 4th St., Cincinnati, Ohio

Robinson Clay Products Co.
1100 Second Natl. Bldg., Akron, Ohio

Griff Robinson
Belle Fourche, S. D.

Rock Products Co.
Nicholas Bldg., Toledo, Ohio

Roche Harbor Lime Co.
Seattle, Wash.

John A. Roebling's Sons Co.
Trenton, N. J.

***Roessler & Hasslacher Chemical Co.**
709 Sixth Ave., New York City

Rogers-Brown & Co.
Chicago, Ill.

H. J. Rolls
Buffalo, N. Y.

Rosiclare Lead & Fluorspar Co.
Rosiclare, Ill.

Rue Clay Co.
South Amboy, N. J.

Russell Engineering Co.
Railway Exchange Bldg., St. Louis, Mo.

P. L. Ryan
Woodbridge, N. J.

St. Louis Fire Brick & Clay Co.
Los Angeles, Calif.

L. A. Salomon Sons
216 Pearl St., New York City

Sandvik Steel, Inc.
Woolworth Bldg., New York City

Sanford Riley Stoker Co.
Worcester, Mass.

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San Francisco Salt Refining Co.
624 California St., San Francisco, Calif.

***The John Sant & Sons Co.**
E. Liverpool, Ohio

Thos. H. Sant & Son Co.
E. Liverpool, Ohio

Savage Fire Brick Co.
Mt. Savage, Md.

Savage Mountain Fire Brick Co.
Frostburg, Md.; 2nd Natl. Bank Bldg., Pittsburgh, Pa.

Schall Color & Chemical Co.
80 William St., New York City

Schurs Oil Burner Co.
5330 Santa Fe Ave., Los Angeles, Calif.

Scobell Chemical Co.
Rochester, N. Y.

Scottish Canadian Magnesite Co.
Magnesite, Que., Canada

Scott Quarry Co.
Sault Ste. Marie, Mich.

Seaboard Feldspar Co.
804 Equitable Bldg., Baltimore, Md.

Sharp-Schurtz Co.
Lancaster, Ohio

T. Shriver & Co.
Harrison, N. J.

Silica Products Co.
Guion, Ark.

Simplex Engineering Co.
Washington Trust Bldg., Washington, Pa.

The Simpson Fdry. & Engineering Co.
Newark, Ohio

E. M. Sly
Belle Fourche, S. D.

A. F. Smith Co.
903 New Harmony Ave., New Brighton, Pa.

Norman G. Smith & Co., Inc.
Spruce Pines, N. C.

Smith & Ellis
Box 215, Peekskill, N. Y.

Solvay Process Co.
Syracuse, N. Y.

South Carolina Clay Co.
751 Georgia Ave., Augusta, Ga.

South River Clay Co.
South River, N. J.

Southern Minerals Corp.
441 Lexington Ave., New York City

Southwark Mfg. Co.
Camden, N. J.

Spar Mountain Mining Co.
Cave In Rock, Ill.

Speers Sand Co.
Berkeley Springs, W. Va.

D. R. Sperry & Co.
Batavia, Ill.

Standard Fluorspar Co.
Karbers Ridge, Ill.

Standard Lime & Stone Co.
Martinsburg, W. Va.

Standard Pyrometric Cone Co.
1538 N. High St., Columbus, Ohio

Stauffer Chemical Co.
Los Angeles, Calif.

J. C. Steele & Sons
Statesville, N. C.

Sterling Salt Co.
29 Broadway, N. Y. City

Stevens, Inc.
101 Marietta St., Atlanta, Ga.

Stockton Fire Brick Co.
Rialto Bldg., San Francisco, Calif.

G. C. Stoll
211 Higgins Bldg., Los Angeles, Calif.

Stowe-Fuller Co.
1205 Rockerfeller Bldg., Cleveland, Ohio

A. W. Straub Co.
3737 Filbert St., Philadelphia, Pa.

Stromberg Electric Co.
223 W. Erie St., Chicago, Ill.

Such Clay Co.
South Amboy, N. J.

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Suckow Chemical Co.
Marsh-Strong Bldg., San Francisco, Calif.

Sullivan, A. H.
389 Arcade Bldg., St. Louis, Mo.

Super Flake Graphite Co.
Chicago, Ill.

Surface Combustion Co.
366 Gerard Ave., New York City

Eugene Suter & Co.
160 Broadway, New York City

The Taintor Co.
2 Rector St., New York City

Tamms Silica Co.
30 N. La Salle St., Chicago, Ill.

Tate-Jones & Co., Inc.
Pittsburgh, Pa.

Taylor Instrument Cos.
Rochester, N. Y.

Chas. Taylor Sons Co.
Cincinnati, Ohio

C. Tennant Sons & Co.
19 West 44th St., New York City

Tennessee Mineral Products Co.
Bristol, Tenn.

Thermal Syndicate, Ltd.
58 Schenectady Ave., Brooklyn, N. Y.

Thorkildsen-Mather Co.
Harris Trust Bldg., Chicago, Ill.

W. R. Thropp Sons Co.
Trenton, N. J.

***Titanium Alloy Mfg. Co.**
Niagara Falls, N. Y.

The Toledo Engr. Co.
427 Nasby Bldg., Toledo, Ohio

The Toledo Mould Co.
Toledo, Ohio

Trenton Flint & Spar Co.
Trenton, N. J.

Thwing Instrument Co.
3339 Lancaster Ave., Philadelphia, Pa.

W. S. Tyler Co.
Cleveland, Ohio

Paul Uhlich & Co.
11 Cliff St., New York City

Union Borax
Chicago, Ill.

United Alloy Steel Co.
Canton, Ohio

***United Clay Mines Corp.**
Prospect & Oakland Sts., Trenton, N. J.

U. G. I. Construction Co.
Broad and Arch Sts., Philadelphia, Pa.

United States Feldspar Corp.
170 Broadway, New York City

U. S. Cast Iron Pipe & Foundry Co.
Burlington, N. J.

U. S. Graphite Co.
1430 Holland St., Saginaw, Mich.

United States Gypsum Co.
Chicago, Ill.

U. S. Refractories Corp.
Mt. Union, Pa.

***U. S. Silica Co.**
122 S. Michigan Ave., Chicago, Ill.

***U. S. Smelting Furnace Co.**
Belleville, Ill.

Universal Gypsum Co.
Fort Dodge, Iowa

Universal Sanitary Mfg. Co.
New Castle, Pa.

M. D. Valentine & Bro.
Woodbridge, N. J.

***R. T. Vanderbilt Co.**
50 E. 42nd St., New York City

Peter Van Schaack
444 W. Huron St., Chicago, Ill.

Veeder Mfg. Co.
Hartford, Conn.

*** Note their advertisement in this issue of THE CERAMIC DIRECTORY.**

R. Veenvliet
Schoharie, N. Y.

Vermont Kaolin Co.
Bennington, Vt.

Viking Pump Co.
Cedar Falls, Iowa

Vitrefrax Co.
Los Angeles, Calif.

Vitreous Enameling Co.
Cleveland, Ohio

***Vitro Mfg. Co.**
927-8 Fulton Bldg., Pittsburgh, Pa.

Vulcan Iron Works
Wilkes-Barre, Pa.

Waltham Grinding Wheel Co
Waltham, Mass.; Clayton, Wash.

Wardrop & Son
Cave In Rock, Ill.

Warren County Garnet Mills
Riparius, N. Y.

Wasem Plaster Co.
Fort Dodge, Iowa

Watt Mining Car Wheel Co.
Barnesville, Ohio

Watson-Stillman Co.
28 Bay St., New York City

Webber-Wood Spar Mining Co.
Rosiclare, Ill.

Wedron Silica Co.
Wedron, Ill.

Weightman-Thompson Co.
Cartersville, Ga.

Welsbach Co.
Gloucester City, N. J.

Wengers, Ltd.
Etruria, Stoke-on-Trent, England

West Side Coal Co.
Brazil, Ind.

Western Diatomite Co.
Portland, Ore.

Western Stoneware Co.
Monmouth, Ill.

Western Wholesale Drug Co.
2nd & Los Angeles Sts., Los Angeles, Calif.

Westinghouse Electric & Mfg. Co.
E. Pittsburgh, Pa.

Wetherill & Bro.
126 S. 30th St., Philadelphia, Pa.

White Heat Products Co.
West Chester, Pa.

White Marble Lime Co.
Manistique, Mich.

Whitehead Bros. Co.
537—9 W. 27th St., New York City

John C. Wiarda & Co.
273 Greene St., Brooklyn, N. Y.

W. W. Wilkins
Lewis Institute, 1951 W. Madison St., Chicago, Ill.

C. K. Williams Co.
Easton, Pa.

Willson Goggles, Inc.
Reading, Pa.

Wilson-Maeulen Co.
386 Concord Ave., New York City

Wing & Evans
40 Rector St., New York City

Winters Metallic Paint Co.
Iron Ridge, Wis.

Wishnick-Tumpeer Co.
Chicago, Ill.

Witherbee, Sherman & Co.
Mineville, Essex County, N. Y., and Port Henry N. Y.

R. D. Wood & Co.
Philadelphia, Pa.

Wyoming Shovel Wks.
Wyoming, Pa.

D. C. Wysor
Owensville, Mo.

Zanesville Mould Co.
Zanesville Ohio

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